

The CONQUEST *of the* AIR



• JOHN • ALEXANDER •



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M. ALBERTO SANTOS-DUMONT.

THE CONQUEST OF THE AIR

The Romance of Aerial Navigation

By
JOHN ALEXANDER

With Preface by
SIR HIRAM MAXIM

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PREFACE.

DURING the last ten years, I have received innumerable letters relating to aerial navigation from all parts of the world. These letters for the most part have been written by people totally unacquainted with the first principles of the question involved. Still each and every one of them has his own particular plan, which to his mind is sure to succeed ; but unhappily the majority of these gentlemen are quite unprovided with the necessary means to exploit their inventions, and in the kindness of their hearts, they appeal to me, expressing themselves as not only willing to give me the controlling interest, but even in some cases the greater part of the glory, providing that I will furnish the necessary cash to develop their inventions.

Fully half of these inventors seem to have thought out a plan of performing mechanical flight by means of flying machines worked by man-power. They admit that their apparatus with a man to work it will weigh at least three hundred pounds, but they never appear to appreciate that in order to lift three hundred pounds directly into the air by mechanical effort, it would be necessary to expend at least three horse-power, or about thirty times as much power as a man is able to exert continuously for a single hour. The greater number of them seem to imagine that the power can be increased almost *ad infinitum*, providing that it is transmitted through a sufficient number of levers, and other mechanical movements.

Next in number to the hand flying-machine inventors come those who would navigate the air by cigar-shaped balloons, and although none of them have anything new to offer, they all write as though they were the first to conceive of this particular form of balloon.

Then we have a number of crane inventors who imagine that they have discovered a way of causing gravity to pull in the other direction, and a still less number who claim to have discovered how flying machines may be worked without any motive power at all, except by a system of springs, levers, and pistons, which to their mind gives a kind of an unbalanced pressure which will push the machine either upward or forward as may be desired.

All these gentlemen expect courteous replies to their epistles, and I have thought that it would be a good plan to publish a cheap, short, and concise treatise on flying machines and balloons, and then recommend each to purchase and read the work before writing to me a second time.

By a perusal of Mr. Alexander's work, I am happy to find the exact treatise that I had in my mind. In this little publication, we have in one hundred and sixty pages the whole history of the subject; in fact everything that is worth knowing, which although written in a short and concise manner is still very attractive, in a word the exact book that is required at the present moment; and I can recommend its careful perusal to everyone who is studying this much-discussed question.

Wm. S. Maxon



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THE CONQUEST OF THE AIR

CHAPTER I.

The Beginning of Balloons—Montgolfier's Fire-Balloon—Charles's Hydrogen Balloon—The First to Ascend—Green's use of Coal-gas and the Guide-rope.

THE more we know of invention and human ingenuity the more are we constrained to the admission that Solomon was everlastingly right when he said that there was nothing new under the sun. At first this remark may appear singularly inappropriate when we come to consider aeronautics; but we are not long in discovering that, though we may choose to regard the brothers Montgolfier as the discoverers of the balloon, and the end of the eighteenth century as its birthtime, we can never hope to reckon without endless instances of balloons and flying-machines long before these ingenious gentlemen lived.

From earliest times man's thoughts had flown upward like the sparks, and it was the most natural of all desires in man to imitate the birds in their glorious freedom of winged flight. At a very early period in his history he had brought the sea under

his dominion, and sighing for fresh fields of conquest, why not the upper ocean at the bottom of which he lived?

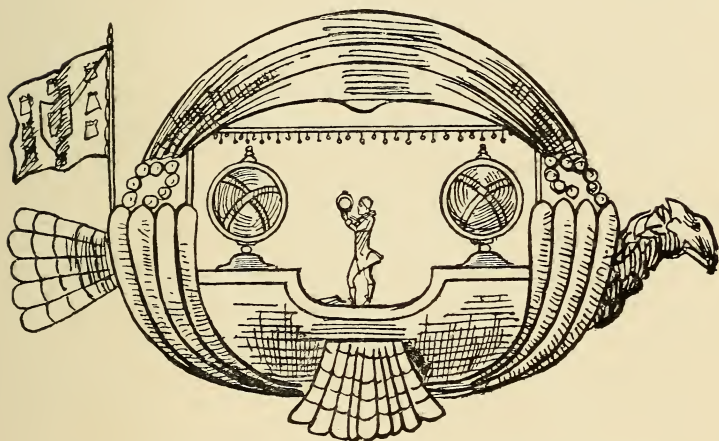
The classic story of Dædalus naturally occurs to the mind. How that celebrated Grecian artist and inventor is said to have devised wings for himself and his son Icarus, when they were both imprisoned in Crete; and how by means of these Dædalus succeeded in flying across the sea to Cumæ, though Icarus was drowned by soaring so high that the heat of the sun melted the wax with which his wings were fastened! The Icarian Sea is named after this early aerial disaster. The story may be a fable, but this celebrated Athenian was the inventor of sails,—he also invented the axe, the wimble, the wedge, and the level,—and it is possible that his escape from the captivity of King Minos in Crete was accomplished by some ingenious use of sails.

But all the earliest attempts at flight through the air were on the lines of Dædalus's winged escape. "The birds fly; why not we?" This would be the attitude of the ancients, and we know what their attitude was after they attempted it.

The early records of our own country contain not a few references to misguided people who thought they could fly. There was, for instance, Oliver of Malmesbury, a learned monk, who made a sorry attempt, and charged his failure to the fact that he had forgotten to put on a broad tail of feathers. Others did not survive to discuss their failures. The earliest would-be flyer who appeared in Scotland must have been something of a humourist. He was

an Italian, and he endeavoured to show James VI. and his court that flying was an easy matter to a clever fellow. Equipped with a pair of huge wings, worked by cords, the adventurer leapt from the wall of Stirling Castle, and, as might have been expected, speedily reached the ground. His reasoning on this unlucky result is worthy of being preserved :

“My wings,” said he, “were composed of various



THE FLYING-MACHINE OF BARTHOLOMEO LOURENCO DE GUSMAO.

feathers ; among them were the feathers of a dunghill fowl, and they, by a certain sympathy, were attracted to the dunghill on which I fell ; whereas, had my wings been composed of feathers of eagles alone, as I proposed, the same sympathy would have attracted my machine to the higher regions of the air.” Still the favour of a fall on a dunghill was not to be despised.

Another monk—this time a Brazilian, named Bartholomeo Lourenco de Gusmao—seems to have

been so successful, early in the eighteenth century, that he was put to death as a sorcerer. The *Evening Post* newspaper of December 22nd, 1709, contained a description of this early Brazilian flying-machine. We also reproduce a drawing of the thing copied from an old cut. The ship was scallop-wise at both ends, and had sails which turned as they were directed. There were two wings to keep it upright, and a stern to govern it. In the body, at each end, were a pair of bellows to be blown when there was no wind, and two globes of metal to cover two loadstones to draw the ship after them. The body was of thin iron plates covered with straw mats, for ten or twelve men besides the constructor. Above the body was a network of iron wire, on which were fastened large amber beads, "which by secret operation would help to keep the ship aloft; also by the sun's heat the mats that lined the ship would be drawn to the amber beads. The aeronaut, by the help of the celestial globe, a sea-map, and compass, was to take the height of the sun, thereby to find out the spot of land over which they were on the globe of the earth."

The desire to fly and the delusion that it is an easy matter have often been experienced by people who could give no reason for either. Ruskin tells us that, as a child, he used to *think* he could fly downstairs. He does not say that he ever tested his belief. Many of our readers will have experienced similar delusions in their early days. The literature of the young has always had a place for flying-men and flying-machines; the classic of that kind being, of course, Jules Verne's *Five Weeks in a*

Balloon. Cyrano de Bergerac and Edgar Allan Poe, to say nothing of Mr. H. G. Wells, have written of flights through the air for children of older growth. It should also be added that more than two hundred years ago a certain King of Burma used to be entertained by a clever native who had invented something which seems to have resembled our modern parachute, wherewith he descended from great heights to the amusement of the Burmese Court.

Whatever the first attempt may have been like, whatever was its result, of this we may be sure, that it took place long ages before the Montgolfiers discovered that heated air could raise a balloon into the skies. That, however, must be our starting-place in this story of the balloon and its beginnings.

Joseph and Etienne (Stephen) Montgolfier were managers of a paper-work at Annonay, in France, and it was Etienne who first demonstrated the practicability of the theories put forward by two scientists of his time, Cavallo and Dr. Black, that solid bodies could be raised in the atmosphere by being attached to vessels filled with gas of a lighter specific gravity than the surrounding air. Cavallo in 1772 had filled and floated soap bubbles with hydrogen in proof of his theory.

In 1783 Etienne succeeded, after many failures, in raising to a height of 1,500 feet a large balloon of linen and paper, thirty-five feet in diameter. In shape this balloon was much the same as thousands that have since been made: an ordinary sphere, and the gas was generated by burning moist straw, wool,

and rags placed on an iron brazier beneath an opening at the bottom of the great bag.

For all practical purposes this was the first balloon. The invention created great excitement in France, which has remained to this day the home of ballooning. Paris immediately started a subscription to construct a great fire-balloon or "montgolfière," as they were called for many a day. The Montgolfiers were the heroes of the hour, patronised even by the king. Curiously enough, Etienne had not sufficient courage to trust himself to be borne aloft by the balloon he had invented.

The first aerial travellers by balloon were a sheep, a cock, and a duck, sent up in a cage attached to a montgolfière, which the inventor raised at Versailles in September of 1783 before the king and court.

The previous month M. Charles, Professor of Natural Philosophy in Paris, had gone one better than Montgolfier, and sent aloft from the Champs de Mars a fine balloon filled with hydrogen, which gas had been first discovered by Cavendish in 1775. This balloon was thirteen feet in diameter. To the present day hydrogen remains the best material for inflating, being used by Señor Santos-Dumont, though it is much too expensive for all but the millionaire balloonist. Professor Charles's balloon fell at Gonesse, fifteen miles from Paris, about an hour after it had been sent up, and the amazement with which the peasantry witnessed its descent has been described in these words:

"It is supposed by many to have come from another world ; many fly, others, more sensible, think

it is a monstrous bird. After it has alighted there is some motion in it from the gas it still contains. A small crowd gains courage from numbers, and for an hour approaches by gradual steps, hoping, meanwhile, the monster will take flight. At length, one bolder than the rest takes his gun, stalks carefully to within shot, fires, witnesses the monster shrink, gives a shout of triumph, and the crowd rushes in with flails and pitchforks. One tears what he thinks to be the skin and causes a poisonous stench; again all retire. Shame, no doubt, now urges them on, and they tie the cause of alarm to the tail of a horse, who gallops across the country, tearing it to shreds."

The government even found it necessary to send a proclamation throughout the country explaining what a balloon was, and counselling the country-folk not to be alarmed if they happened to see one. In our own day the Russian Government had to do a very similar thing in connection with Andree's attempt to reach the North Pole in a balloon. Some parts of the world move with the ages, others remain stock still.

The distinction of being the first of men to ascend into the air by means of a balloon belongs neither to the Montgolfiers nor to Professor Charles. Strangely enough, this honour rests with two men who ascended together, and one of whom—the Marquis d'Arlandes—was subsequently "broke for cowardice" in the discharge of his military duties at the beginning of the French Revolution. Pilâtre de Rosier was the name of his companion in the first balloon ascent, which took place from the palace of La Muette

in the Bois de Boulogne, Paris, on November 21st, 1783.

From this time forward, according to an old writer, until the fatal termination of his career, M. Pilâtre de Rosier seems to have devoted himself entirely to the practice and improvement of the art of aerostation ; a pursuit in which, however, he was not long destined to continue. On June 15th, 1785, in company with a young gentleman, named Romain, he ascended at Boulogne sur Mer with the intention of crossing the channel into England by means of his balloon. Unfortunately the arrangements which he adopted to secure his success were the cause of his failure as well as of his destruction. In order to counteract the fluctuations consequent upon all aerial excursions under the ordinary circumstances, and obtain the power of increasing or diminishing the weight of his apparatus at will, without the usual expenditure of gas and ballast, he had conceived the idea of uniting in one the two systems of Montgolfier and Charles, and, accordingly, attached to the hydrogen balloon, by which the principal part of the weight was to be borne, a small montgolfière or fire-ballon, by acting upon which he expected to be able to alter his specific gravity as occasion might require. As our authority points out, the theory was correct : the error lay in the application. Distended in the course of its elevation, the inflammable contents of the larger sphere soon filled the vacant portions of the silk, and pouring down the tube, which formed the neck of the balloon, speedily reached the furnace, which was disposed at its lower extremity, and

became ignited. The whole apparatus was consumed in the air, and the two unfortunate voyagers precipitated upon the rocks which bound the shores of the sea between Calais and Boulogne.

Concurrently with these French experiments two American scientists, Rittenhouse and Hopkins, of Philadelphia, were also experimenting; and there is every reason for believing that their application of hydrogen to the inflation of a balloon was made independently of Professor Charles's experiment. Instead of one large balloon, however, their aerostat consisted of forty-seven small balloons, to which a cage was attached. The scientists, careful of their own necks, induced a working carpenter, named James Wilcox, for a monetary consideration, to ascend in this cage at Philadelphia on December 28th, 1783, and thus the first American to soar aloft into the air of liberty did so as a mercenary. In descending he narrowly escaped the broken neck which his employers had dreaded.

The next ascent was undertaken by Professor Charles from the Champs de Mars on December 18th, 1783, in a balloon of twenty-seven feet in diameter, inflated with hydrogen. Charles was accompanied by a M. Robert, one of the makers of the balloon, and after returning to the ground, excited probably by his success and ignorant of the laws of ballast, he reascended alone, and went up with terrific velocity, owing to the sudden abstraction of so much weight. It is supposed that he reached an elevation of about 10,500 feet. After having experienced, according to his own description, much inconvenience from the

altitude he had attained, he effected his descent without further danger or damage.

It is recorded by a contemporary pamphlet that MM. Charles and Robert were arrested, on returning to Paris, by order of the king, who, at the suggestion of two of his ecclesiastics, adopted this course to prevent the further endangering the lives of his subjects; but they were speedily discharged.

Joseph Montgolfier would now appear to have summoned up courage to risk a rise—or a fall—in a fire-balloon at Lyons, on January 19th, 1784. The experiment was one of the most important of all the early ascents, being on a scale which was not exceeded for many years after. It will, therefore, be well to give a very full account of it, drawn from one of the earliest writers on aeronautics. The balloon employed was a pyriform vessel, constructed of two layers of linen cloth, enclosing one of paper between them (for the purpose of increasing its imperviousness), and measured, when fully inflated, 130 feet in height and 105 feet in breadth. It was capable of containing 40,000 cubic feet of air, and, when charged for the ascent, supported with ease seven persons and ballast to the amount of 1 ton 9 cwts. independent of its various accessories; its car, in the form of a gallery, seventy-two feet in circumference, accommodated with seats, four feet wide and eight apart; its furnace, twenty feet in diameter, with its fuel made up into faggots of wood and straw; its massive framework to maintain the lower aperture; its drapery, netting, cordage, implements, and other requisites all in the same

proportion, the approximate weight of which it would be impossible now to determine.

The names of those who participated in the honour of this expedition were, Joseph Montgolfier himself, under whose direction the whole had been got up, Pilâtre de Rosier, le Comte de Laurencin, le Marquis de Dampierre, le Comte d'Anglefort, le Prince Charles de Lignes, and a young man named Fontaine, who, happening to be in the car at the moment when, suddenly lightened by the hasty departure of another gentleman, it escaped into the air, became accidentally included in the party. In a few seconds it rose to an elevation of about 3,000 feet ; an opening, however, of about four feet in length, which appeared about the equator of the balloon, soon brought it down again, with a velocity even greater than its ascent, and it reached the ground at a distance of about 12,000 feet from the place of its departure.

There is no record of Joseph Montgolfier ever having repeated the performance, and the next ascent worthy of notice was the first that took place from British soil. This experiment has the triple distinction of being the first by a native of Great Britain, the first in our own country, and the only one for half a century ever carried out on the principle of the Montgolfiers' fire-balloon. The name of the daring Britisher was James Tytler, and Comely Gardens, Edinburgh, was the scene of his ascent. It took place on August 27th, 1784, and is thus described by an eye-witness in the *London Chronicle* :

“Early this morning this bold adventurer took his

first aerial flight. The balloon being filled at Comely Gardens, he seated himself in the basket, and the ropes being cut, he ascended very high, and descended quite gradually on the road to Restalrig, about half a mile from the place where he rose, to the great satisfaction of those spectators who were present. Mr. Tytler went up without the furnace this morning; when that is added he will be able to feed the balloon with inflammable* air, and continue his aerial excursions as long as he chooses. Mr. Tytler is now in high spirits, and in his turn laughs at those infidels who ridiculed his scheme as visionary and impracticable. Mr. Tytler is the first person in Great Britain who has navigated the air."

It is well that this exploit of Tytler's should be remembered, as it is a common error to credit a Signor Lunardi, a gentleman attached to the Neapolitan Embassy in London, with having made the first ascent in England, though in reality his ascent was made from the Royal Artillery Grounds, Moorfields, on September 15th, 1784, almost a month after Tytler's performance. Lunardi made many other ascents in England and Scotland before returning to his native country to gratify the curiosity of the Italians, and, finally, to die in great poverty. The first balloon ever sent up in England was launched in London on November 25th, 1783, by Count Zambecari; but that celebrated acronaut did not ascend himself until March 23rd, 1785, when, in company with Sir Edward Vernon, he

* A misnomer due to the correspondent's ignorance of the principle of inflation.

made an aerial journey of twenty-five miles, landing at Horsham in less than an hour from leaving London. Zambeccari was one of the earliest victims of the dangerous montgolfières, having to make a fatal plunge from a burning balloon at Bologna on September 21st, 1812. His companion on that occasion escaped, but with fearful injuries.

Such, then, was the beginning of ballooning. It will be gathered that the montgolfière was a very crude contrivance, and that a great step had been made the moment Professor Charles had proved the practicability of hydrogen as a material for inflation. The wonder is that the fire-balloon remained in use as long as it did. Damp straw, rotten meat, old boots—these were the fuel with which the heated air was generated, and the stench from the fire, apart altogether from the danger of the thing, was most offensive. No wonder that Louis XVI. wished to prevent respectable citizens from risking their lives in such contrivances, and desired that the first men to ascend in one of these fire-balloons should be two criminals condemned to death. The proud and courageous Rosier was indignant "that vile criminals should have the glory of being the first to rise in the air," and, as we have seen, he carried his point, and his was the glory.

With the use of hydrogen the balloon became, almost at one step, the machine which is familiar to all to-day, and has remained practically unchanged in any essential detail for upward of a hundred years. The principle of its construction is simplicity itself. A large pear-shaped bag of silk or linen, or both,

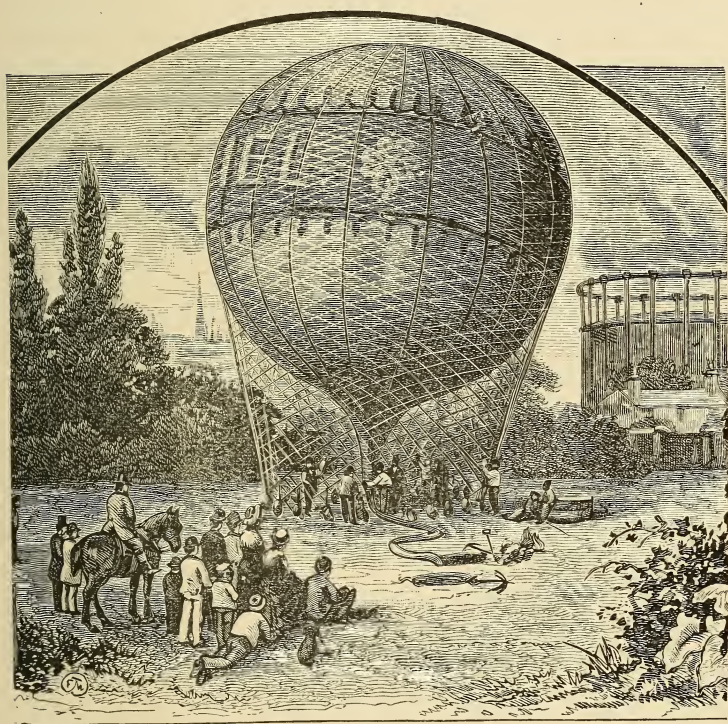
well varnished—to make it as nearly air-tight as possible—with an open neck hanging downwards, and at the top a valve which can be opened when the aeronaut wishes to descend by letting out a quantity of gas. Over the balloon is a network of rope meshes from which the car, or basket, is suspended.

Ballast, in the shape of bags of sand to be thrown out as required, is the only method of changing the rate of upward progression, and vertical motion is the only direction in which the aeronaut has any control over the balloon. He cannot move it to the right or left ; there it is at the mercy of the air-currents. A handful of ballast thrown out may send it up twenty yards, a whole bag thrown out would mean an upward rush at a tremendous speed. Even a chicken bone thrown out of the car has caused a rise of thirty yards!

In the higher latitudes where the atmosphere becomes lighter the gas in the balloon expands, and for this reason the neck is left open, or fitted with a self-acting valve which enables the expanding gas to escape into the air. If the bag were closed it would burst when it reached the region of lighter air.

It was to an Englishman, Charles Green, the most famous British aeronaut, who flourished in the first part of last century, that we owe the invention of the guide-rope and also the use of ordinary coal-gas for inflation. Hydrogen is much more buoyant, but many times more expensive and infinitely more difficult to apply. The guide-rope is used when travelling at any altitude up to

1,000 feet or thereabout above the ground. It hangs down from the car and, touching the ground, acts as a kind of support, enabling the balloon to travel at a fixed height over great distances. The moment



INFLATING A BALLOON WITH CARBONIC ACID GAS.

the rope trails on the ground the part touching the earth is like ballast thrown out, and releases the balloon to that extent, while the part still hanging acts as ballast retained and equalises this effect. It is also of immense use in breaking the rate of descent

and has often been the means of saving life. Since these inventions of Charles Green nothing has been done until quite recently to improve the construction of the balloon, as distinct from the aerial machine, and nothing more than the Hervé *deviator* (of which some account is given further on) is ever likely to be added to the ordinary gas-balloon.

CHAPTER II.

Some Famous Aerial Voyages—First Across the Channel—The Adventures of Zambeccari—The Voyage of the "Great Nassau"—Across the Alps—Seven Miles High—Colonel Burnaby.

IN our previous chapter we have dealt only with early ascents which could scarcely be dignified with the name of aerial voyages. We come now to the chronicling of some travels through the air that are worthy to rank with the most daring exploits of the world's famous explorers; and the only difficulty in treating of this subject is deciding what to select for description. One could fill volumes with intensely interesting stories of aerial travel, so rich is the history of ballooning in adventure and surprise. We can only hope to mention briefly a few of the most notable of these celestial explorations.

The first ambition which fired French aeronauts was to cross the channel and invade England from the sky. But it so happened that the process was reversed in the first instance, and, like a homing pigeon, a celebrated French aeronaut, Blanchard by name, crossed—in company with an American, who supplied the money for the balloon—from Dover to France on New Year's Day, 1785. Blanchard, who

was one of the first to attempt to fit a balloon with steering apparatus, had taken enthusiastically to the new pursuit, and developed great skill in it. He was anxious to make the first trip across the channel alone, and only took the American Jeffries with him on condition that if at a critical moment it was found there was one too many in the car Jeffries would jump out!

Their voyage was fairly exciting, and at one point, when all their ballast had been thrown out, as well as every item that could be dispensed with, down to a great part of the travellers' clothing, it looked as if Jeffries would have to keep his bond, for the balloon was still sinking. At the critical moment, however, it regained its buoyancy and eventually landed in France near the forest of Guines, where the two adventurers, whose voyage had been a great source of excitement to the sailors afloat on the waters of the channel, embraced each other and opined that they were "the most celebrated men in the whole world." The King of France commanded Blanchard to appear at court, and awarded him a pension of fifty pounds.

Altogether Blanchard made about forty aerial voyages; and his wife also became famous as a balloonist, eventually to be dashed to death over Paris, on July 7th, 1819, by her balloon becoming ignited through the discharge of some fireworks which she had foolishly taken up, the occasion being a fête at the Tivoli Gardens.

As we have already heard, Count Zambeccari, in March of the year 1785 made a voyage from London

to Horsham almost worthy of inclusion under our present heading; but his other exploits were far more important. His descents into the Adriatic in 1803 and in 1804 were the most remarkable of his voyages. On the latter occasion he was accompanied by Dr. Grassetti and Pascal Andreoli.

The balloon was a montgolfière, and had a rudder, which only rendered it the more dangerous. They ascended from Bologna at night, hoping that the north-east wind then blowing would carry them to Milan. The ascent was far more rapid than Zambeccari had reckoned on, and they shot up into a region of intense cold. The count, who had been without food for twenty-four hours, soon fell to the bottom of the car in a faint, while Grassetti also lost consciousness, and Andreoli addressed himself to the task of reviving them.

When Zambeccari regained his senses the aeronauts could form no idea as to where they had drifted. Presently the dread sound of breaking waves was heard, and the count hastily tried to throw out a bag of sand, but before he could do so, the car was dragging through the roaring waters of the Adriatic.

What a terrible situation in the dusk of early morning, for it was just a little after three o'clock when the involuntary descent occurred! Madly did the two aeronauts throw overboard every bag of ballast, and cut away everything that could be dispensed with. The result was another ascent, more rapid, more fearful than the first. They gained an altitude such as no mortal man had ever reached before. Their clothes became coated with ice,

Andreoli bled profusely, and the poor doctor still lay as one dead.

A half-hour was passed in this region of killing cold, and then down fell the balloon again, for the wretched furnace had failed in its work—thanks to the waves, no doubt—and the envelope was largely depleted of heated air. The balloon now served as a sail, and dragged the frail car through the water, while the worn-out adventurers abandoned themselves to their fate. Daylight at last, and they saw the shore four miles away. They were being dragged rapidly thither, but suddenly the wind changed and blew them out to sea again. Some boats put off to rescue them, but when they drew near the sailors were amazed at the uncanny spectacle and, ever superstitious, drew back inshore. Fortunately a vessel hove in sight, and the captain had the sense to comprehend the situation, so that the balloonists were rescued. The balloon, freed from their weight and cut adrift from the car, soared aloft with amazing rapidity and was for ever lost—a derelict of the upper ocean!

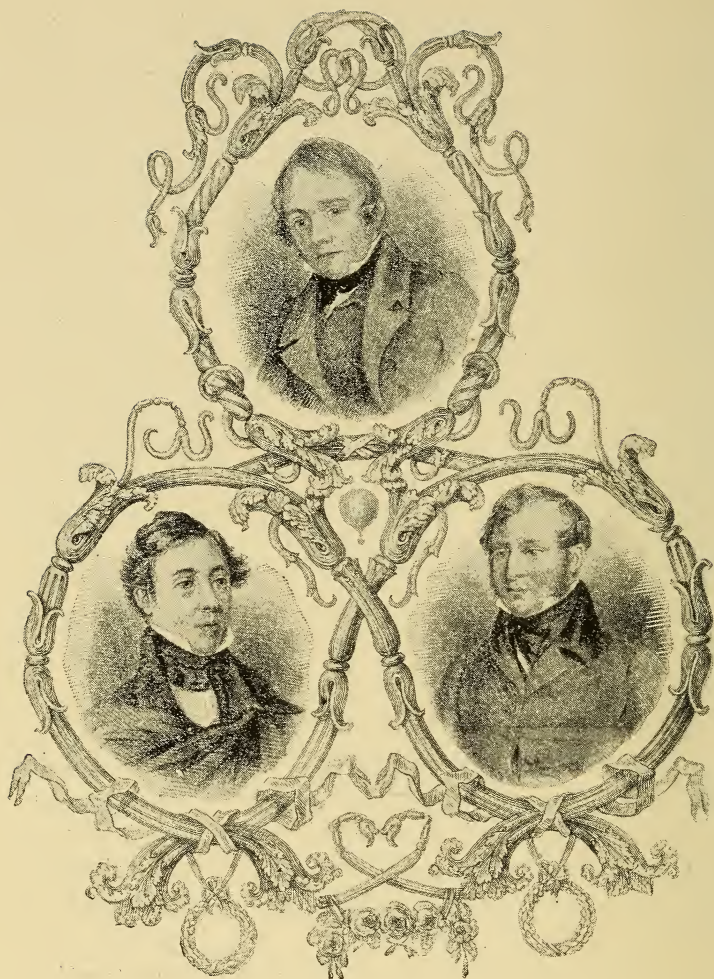
One of the next longest voyages was also an involuntary one. It came in the experience of another French aeronaut, A. J. Garnerin, who, in an ascent from the Tivoli Gardens at Paris on September 21st, 1807, in a balloon decorated with lamps and containing fireworks for an aerial display, soon found himself in a dangerous pass, owing to the distension of his balloon and the inability under which he lay of discharging the gas, for fear of its taking fire at some of the numerous lamps, that, owing to

the distance at which they were disposed, he was unable to extinguish.

In these straits, says an early writer, he was fain to continue until the following morning, when the lights expiring of their own accord, permitted him to take the necessary steps for his descent. The name of Garnerin is, however, more particularly remembered on account of his having been the first who ever safely descended from a balloon by means of a parachute: an exploit which he originally performed in an ascent from Paris, on October 21st, 1797, and afterwards repeated on other occasions in England, France, and various places on the Continent. The number of his ascents is said to have exceeded fifty.

The science or art of ballooning had already become a profession at which many men and some women were making their living. There was, indeed, but little science about it, as most of these early ascents and voyages were undertaken either for public amusement or adventure, few for scientific purposes. Many years passed without science profiting to any extent from aeronautics. But the purely scientific aspect of the pursuit is left for special treatment in our next chapter.

It was not until 1836 that any outstanding achievement again attracted universal attention, and this time, we are happy to record, the honour lay with Englishmen. Charles Green, to whom reference has already been made as the most famous aeronaut of his time, although he may be regarded as the father of modern ballooning, was not a scientist,



CHARLES GREEN.

ROBERT HOLLOND, M.P.

MONCK MASON.

The aeronauts who made the first balloon voyage from England to Germany
in 1836.

and his accomplishments were all associated with the practical side of ballooning. In his time some of the pleasure gardens in London had balloons for public entertainment, just as the Crystal Palace has to-day, and it was at these resorts that Green practised his art. His greatest project was carried out in an immense balloon belonging to the Vauxhall Gardens and in the company of two gentlemen of leisure, one being Robert Hollond, a member of Parliament, the other, Monck Mason, who has left a full account of their great voyage in his book *Aeronautica*, a crude literary performance, but a mine of information to the historian of aeronautics.

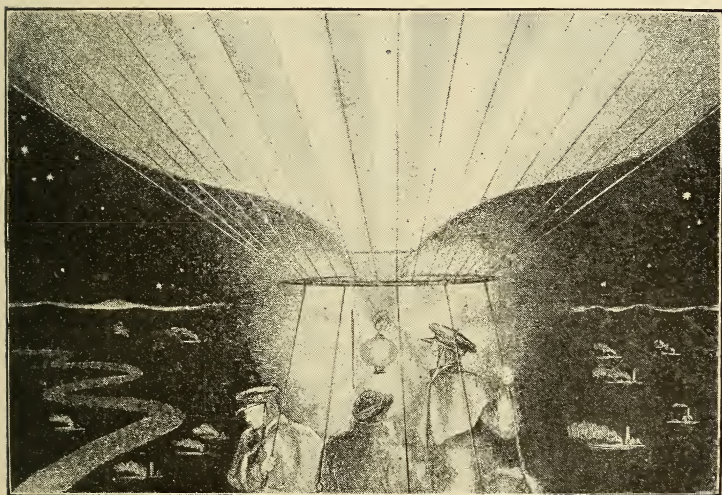
The balloon in which this famous aerial voyage was effected was afterwards named the "Great Nassau," for a reason which will appear in due course. It was built by Green, and was on a gigantic scale. Pear-shaped, as will be seen from our illustration (page 37), it had a very elegant appearance, and was made of the best silk, specially woven. Each gore was about forty-four inches wide, and coloured alternately white and crimson. Down each seam, and worked in the original material, was a ridge of extra thickness to increase its strength. Its height was over sixty feet and it was nearly forty feet in diameter. It could hold 85,000 cubic feet of gas, and had a lifting power of 4,000 pounds. The car of wicker-work had two seats at each side capable of accommodating three persons, and in the centre a bench to keep the wicker-work in shape and also to serve as a frame for raising or lowering the guide-rope, to test

which was one of the objects of the journey. The car was suspended by ten stout ropes to an ash hoop six feet in diameter, which hung from the network covering the balloon. It was fitted with a stock of provisions to last a fortnight in case of emergency, and, for greater safety, instead of a stove for heating coffee or other liquor, was a machine which generated heat by means of slaking quicklime. But a lamp was used for giving light at night. The balloon of course, was inflated with ordinary gas. A few scientific instruments were also carried.

At half-past one on Monday, November 7th, 1836, the memorable voyage commenced in "uncommonly fine weather." It was nearly three o'clock when they crossed the Medway, and soon they were scudding over Canterbury, into which they lowered a small parachute with a letter to the mayor. As the evening came on and the air grew colder the condensation which took place on the balloon gradually caused it to fall, until they were running so low that they frightened partridges from their covers and could see the birds distinctly. Mason also records the dismay which the balloon occasioned among a colony of rocks as it passed over some woods. The travellers were in great spirits, and Mason waxed enthusiastic about the joy of ballooning : "The most delightful and sublime of all sublunary enjoyments!" he exclaims.

When the balloon was over Dover Castle it was travelling at the rate of twenty-five miles an hour, and presently they were skimming across the English Channel. Mason, in atrocious English, describes the scene :

"On either side below us the interminable ocean spread its complicated tissue of waves without interruption or curtailment, except what arose from the impending darkness, and the limited extent of our own perception. Slightly agitated by a wind, unfelt by us, its pliant surface glistened faintly as it rose and fell, catching for an instant by the momentary obliquity of its parts the few rays of light that



THE "GREAT NASSAU" AT NIGHT, PASSING OVER THE DISTRICT
OF LIÈGE, IN BELGIUM.

(From a sketch by Monk Mason.)

still lingered above the horizon and losing them again as they turned their opposing outlines towards a darker quarter."

Through openings in the floor of cloud, which lay beneath them when they rose into higher altitudes, they could occasionally see a solitary ship flit across

the stretch of sea thus revealed, "like the spectral representation in some magic lantern." In an hour from leaving the shore of England they were floating tranquilly over the fair fields of France now darkening under the pall of night (5.50 p.m.).

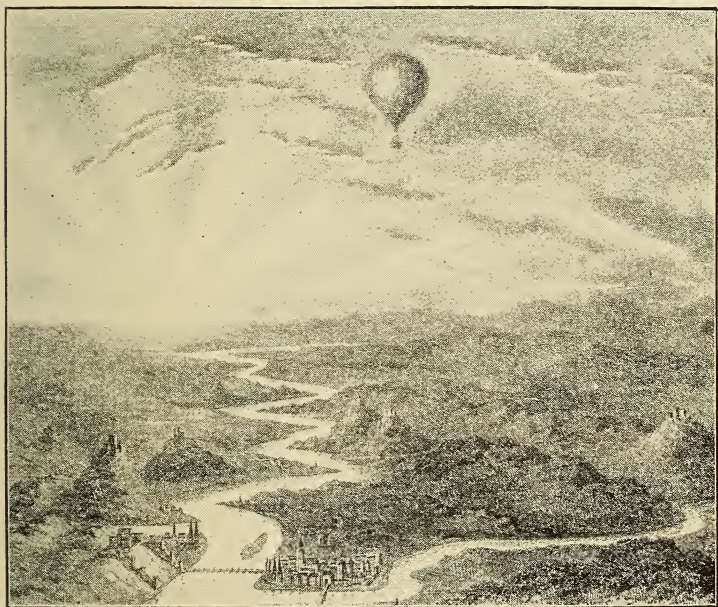
So speedily and easily had they crossed the channel that there had been no opportunity to test the copper floats attached to their guide-rope, for the purpose of using that to the same effect as on land. But once over the land a guide-rope of about a thousand feet was let out and acted perfectly, the balloon steadily proceeding on its way through the air, if one can so describe a progress which is absolutely imperceptible to those in the car.

The delight with which the voyagers saw the landscape of night is expressed not badly by Mason :

"The whole plane of the earth's surface, for many and many a league around, as far and farther than the eye distinctly could embrace, seemed absolutely teeming with the scattered fires of a watchful population, and exhibited a starry spectacle below that almost rivalled in brilliancy the remoter lustre of the concave firmament above."

And so they sped all through the lovely night, vaguely guessing at the land which lay beneath them, but rightly concluding that a "fiery region" over which they passed was the iron-smelting town of Liège in Belgium. "The sky, at all times darker when viewed from an elevation than it appears to those inhabiting the lower regions of the earth [note the aeronaut's superiority !] seemed almost black with the intensity of night." In these circumstances they

found the guide-rope invaluable, as it warned them when they were nearing hills. When travelling at a good height, over fairly even ground, the rope hangs at an acute angle from the car, but when the ground is rising the rope begins to drag behind and thus to warn the aeronauts that a handful of ballast thrown



THE "GREAT NASSAU" PASSING OVER COBLENTZ.
(From a sketch by Monck Mason.)

out may lift them over some higher land which they are approaching.

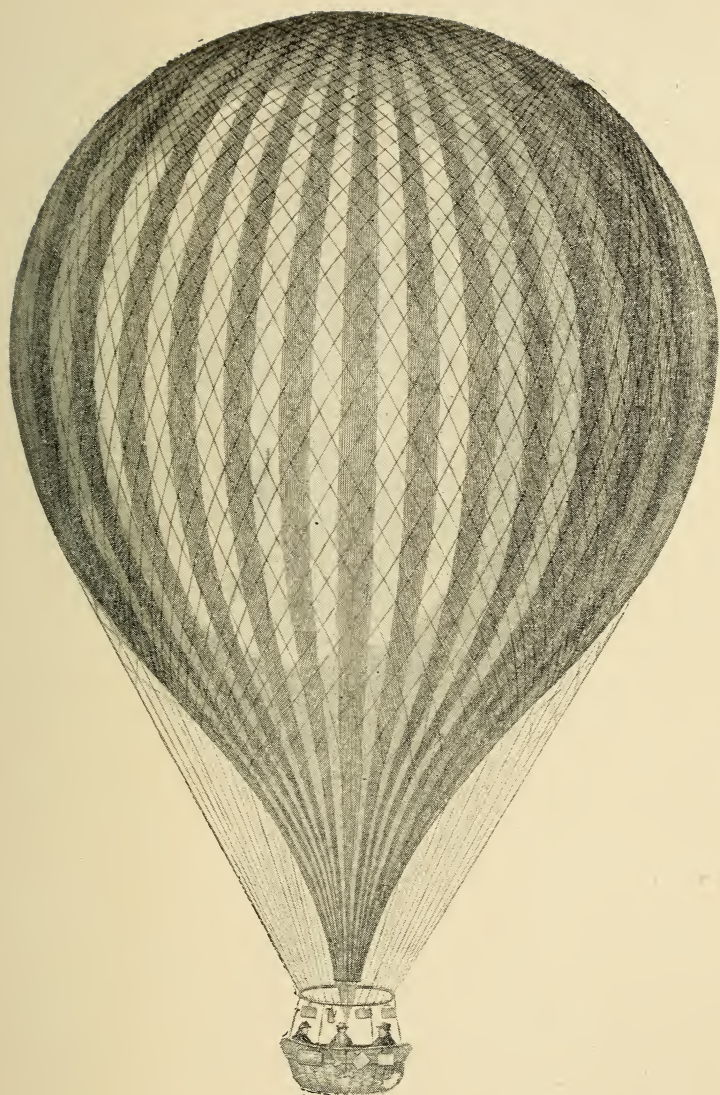
"In one of these latter movements," says Mason, "which took place at about a quarter past six (a.m.), the balloon, having nearly recovered its highest elevation, suddenly brought us in full view of the

sun, and for the first time gladdened us with the assurance of a speedy return of day. Powerful, indeed, must be the pen which could hope to do justice to a scene like that which here presented itself to our view. The enormous extent of the prospect—the boundless variety it embraced—the unequalled grandeur of the objects it displayed—the singular novelty of the manner under which they were beheld—and the striking contrast they afforded to that situation and those scenes to which we had so long and so lately been confined, are effects and circumstances which no description is capable of representing in the light in which they ought to be placed, in order to be duly appreciated.”

Finally, their descent took place in the most successful manner near the town of Weilburg in the Duchy of Nassau at half-past seven o'clock in the morning. They could easily have continued their journey for many miles, but had arranged not to get too far away from Paris, whither the balloon, now christened the “Great Nassau,” had to be sent for exhibition purposes. In eighteen hours the balloon had carried the travellers across more than 500 miles of land and sea. It took “six long days and longer nights” to cart it to Paris.

The voyage still ranks as one of the most ambitious exploits in ballooning; but was subsequently excelled by the aerial voyage of two Americans, Wise and La Fontaine, who are credited with having travelled 1,150 miles in less than twenty hours.

Charles Green died in 1870 at the ripe old age of eighty-five, having long lived in retirement. From



THE "GREAT NASSAU" BALLOON.

(From a sketch by one of the voyagers, Robert Holland, M.P.)

1821 to 1857 he made no fewer than fourteen hundred ascents, thrice crossed the sea, and twice fell into it. As already recorded, his great services to aeronautics were the invention of the guide-rope and the discovery that carburetted gas could be used for inflation.

Many instances could be given of the great value of the guide-rope. One will suffice. When W. de Fonvielle, the celebrated French balloonist, was making an involuntary descent over Paris, in the famous and unwieldy "Giant," falling through the air at a frightful speed, the guide-rope arrested the descent, and by breaking the force of the downward rush saved the balloon and its occupants from disaster.

M. de Fonvielle comments on the episode thus: "In less than one minute we travelled along a vertical line a distance of 1,300 feet. As the air could no longer bear our weight, the brave 'Giant' had extended itself and formed a kind of parachute. . . . A weight of some 7,000 or 8,000 pounds avoirdupois had thus fallen to the earth with the speed of an ordinary railway train, and without any accident that would be remembered three days afterwards, and all this thanks to the guide-rope."

The next most daring aerial voyage was accomplished by a Frenchman named Arban, who in the early part of 1846 crossed the Alps in a balloon. The journey was an exciting one, as the weather turned out rough, and he found himself looking down on the virgin peaks of the Mont Blanc range in the middle of a stormy night, the moon shining brightly at intervals and lighting up the strange weird scene, such as no mortal eye had ever before witnessed.

He landed near Turin and was the object of a great ovation. Like Zambeccari, he also had a terrifying experience in the Mediterranean and was saved, only to meet, a few years later, an unseen fate in the waters of that sunny sea.

If our purpose were merely to record balloon adventures there would be no lack of material for a much bulkier volume than the present, but the fact that we aim at chronicling only a few of the most notable voyages precludes mention of many exciting episodes, such as the remarkable escapes from death experienced by Green, Coxwell, and a score of others; so we pass now to the next most noteworthy achievement in ballooning, namely, the highest ascent ever accomplished. This was attained by H. T. Coxwell and James Glaisher on September 5th, 1862. It was one of a series of eight ascents—and the most important of the series—made by Glaisher on behalf of the British Association.

As both men are famous in the roll of British aeronauts a word or two concerning them may be given here. Henry Tracey Coxwell was born in 1819 at the Parsonage House, Wouldham, near Rochester Castle, being a grandson of the Rev. Charles Coxwell, D.L. for Gloucestershire, and his father was Commander Joseph Coxwell, R.N., who placed his son for education at the Military School, Chatham. In early life he became an enthusiastic amateur balloonist, and one of his earliest ascents—if not the earliest—was from the White Conduit Gardens, North London, in 1844. In the following year he projected and edited *The Aerostatic Magazine*, and after-

wards made numerous ascents with Hampton, Gypson, Albert Smith, Lieutenant Gale, and others. In 1848 he commenced as a professional aeronaut, and began his first campaign by a series of ascents on the Continent, starting at Brussels with a typical war balloon he had constructed. He afterwards made many ascents in our own country. His last public ascent was made in 1885 at York, from which city he had ascended for twenty-eight years consecutively.

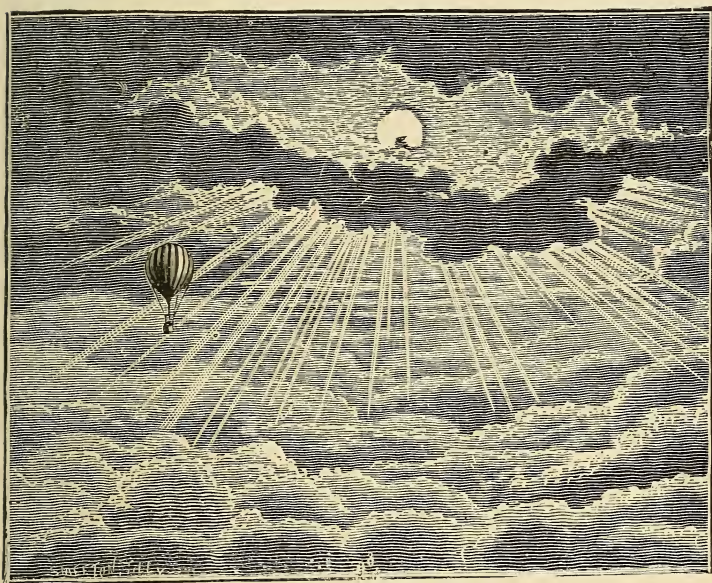
James Glaisher was a Fellow of the Royal Society, a scientist of high repute, and at one time President of the Aeronautical Society. At the time of those ascents in 1862 he was Superintendent of the Meteorological Department in Greenwich Observatory, with which branch of service he was connected from 1840 to 1874, a period of thirty-four years.

Coxwell was the aeronaut and Glaisher the scientist of these ascents, the character of which brings them, with this one exception, into consideration for our next chapter rather than the present. The ascent of September 5th, was the second from Wolverhampton and commenced shortly after one o'clock. In about half an hour the balloon had risen to a height of four miles, and when they had gained an altitude of five miles Glaisher began to be affected by the atmosphere, or, rather, the scarcity of it.

He could no longer read his scientific instruments ; he endeavoured to lift his right arm, it was powerless. So was his left. He could shake his body, but his arms remained useless. Presently he fell back with his head resting on the edge of the car. "I dimly

saw Mr. Coxwell," he writes, "and tried to speak, but could not. In an instant, intense darkness overcame me; but I was still conscious, with as active a brain as at the present moment while writing this." Soon, however, he became quite unconscious.

When Glaisher was falling into this condition,



MESSRS. GLAISHER AND COXWELL'S DESCENT.

Coxwell had clambered into the hoop in order to reach the neck of the balloon, which had become encrusted with hoar frost owing to the intense cold. When the aeronaut returned to the car he found that his hands were frozen. Seeing the plight of his companion he made to examine him, only to find that he himself was powerless and rapidly losing

consciousness. Alert to their great peril, he seized the valve-line with his teeth, and tugged at it until the balloon began to descend. Glaisher gradually recovered, and resumed his note-taking as if nothing had happened. He was able to prove from his instruments that they had ascended to a height of nearly 37,000 feet, or more than seven miles, in less than an hour. Mr. Stanley Spencer, a well-known living aeronaut, has asserted that his ascent from the Crystal Palace on September 15th, 1898, was a "record," despite the fact that he only claims to have risen to 27,000 feet, whereas Glaisher had recorded 29,000 *before* he became insensible, and at that time the balloon was still rising.

Nine years later Gaston Tissandier and two other French scientists were less fortunate in attempting a high ascent. Tissandier escaped, but his companions died from the effects of the rarefied atmosphere in the unrecorded region to which they rose.

Glaisher was so occupied with his scientific observations that he seldom recorded his impressions of the voyage from the popular point of view, but this description of his passage over London on the night of October 2nd, 1865, is worthy of quotation :

"Almost immediately under, but a little to the south-east, was Woolwich ; north, was Blackwall ; south, Greenwich and Deptford ; and west, as far as the eye could reach, was London—the whole forming a starry spectacle of such brilliancy as far to exceed anything I ever saw. When I have been at this elevation in the evening, at a distance from London, it has had the appearance of a vast conflagration, but

on this night the air was so clear and free from haze, that each and every light was distinct, and they seemed all but touching each other.

“On leaving Charing Cross I looked back over London, the model of which could be seen and traced—its squares by their lights ; the river, which looked dark and dull, by the double row of lights on every bridge spanning it. Looking round, two of the illuminated dials of Westminster clock were like two dull moons. Again, looking westward, the whole lines of the Commercial and the Whitechapel Roads, with their continuations through Holborn to Oxford Street, were visible and most brilliant and remarkable. We were at such a distance from the Commercial Road that it appeared like a line of brilliant fire, assuming a more imposing appearance when the line separated in two, and became most imposing just under us in Oxford Street. Here the two thickly studded rows of brilliant lights were seen on either side of the street with a narrow dark space between, and this dark space was bounded, as it were, on both sides by a bright fringe, like frosted silver. At first I could not account for this appearance ; but presently, at one point more brilliant than the rest, persons were seen passing, their shadows being thrown on the pavement, and at once it was evident this rich effect was caused by the brilliant illumination of the shop-lights on the pavements.

“I feel it impossible to convey any adequate idea of the brilliant effect of London, viewed at an elevation of 1,300 feet, on a clear night, when the air is free from mist.

"It seemed to me to realise a wish I have felt when looking through a telescope at portions of the Milky Way, when the field of view appeared covered with gold-dust, to be possessed of the power to see those minute spots of light as brilliant stars; for certainly the intense brilliancy of London this night must have rivalled such a view." *

A sensational ascent was that from Calais, in July, 1873, by Jules Durnot, who started with his wife in most unpropitious weather to cross the channel. They were carried out into the North Sea, where, late at night and after the most exciting adventures, they were rescued by a Grimsby fishing-boat.

Another exciting experience befell Gaston Beauçon, who, in a balloon named the Jupiter, and accompanied by two friends, was carried out to sea from Havre some years ago, and, after a terrible night, had the good fortune to be rescued by a German vessel. The balloon made its way to England, where the weight of snow and ice which it had accumulated brought it to earth.

Among the stories of balloon adventures the travels of the late Colonel Frank Burnaby deserve some mention. He was a member of the Aeronautical Society, and made his first ascent in 1864, with a French aeronaut named Goddard, and later had a very exciting experience with a deluded countryman of Goddard's, who thought he had invented machinery for making his balloon ascend into the skies. Burnaby's great feat, however, was that of crossing the channel in a balloon which he piloted alone.

* *Travels in the Air.* Edited by J. Glaisher. London: Bentley.

CHAPTER III.

Achievements of Recent and Living Balloonists—Flammarion, Tissandier, and de Fonvielle—Andree, the Adriatic, and the North Pole—Rev. J. M. Bacon, Perceval and Stanley Spencer, Count de la Vaulx, etc.—The latest Channel Passage.

WE come now to the achievements of recent and living aeronauts, and among these the names of Camille Flammarion, the celebrated French astronomer, Gaston Tissandier, who, in 1883, was thought to have partially solved the problem of steering a balloon, and W. de Fonvielle are most distinguished. The exploits of Señor Santos-Dumont are left for more particular treatment further on. As with Glaisher, the impulse of the three famous Frenchmen just named was mainly scientific, but they have all come under the fascination of a pursuit which is perhaps the most romantic left to man.

M. Flammarion expresses his feelings in this impassioned address to his balloon as it lay formless in its shed before inflation:

“Inert and formless thing, that I can now trample under my feet, that I can tear with my hands, here stretched dead upon the ground, my perfect slave, I am about to give thee life that thou mayest become my sovereign. In the height of

my generosity I shall make thee even greater than myself. O vile and powerless thing! I shall abandon myself to thy majesty, O creature of my own hands! and thou shalt carry me beyond my kingdom into thy own element, which I have created for thee; thou shalt fly off to the regions of storms and tempests, and I shall be forced to follow thee. I shall become thy plaything; thou shalt do what thou wilt with me, and forget that I gave thee life. . . . Perchance thou wilt deprive me of my existence and leave my corpse floating in the hurricane above, until thy perfidy, fatigued by its own exertions, shall fall like a blind monster in some desert place, or into the foaming waves, which shall swallow us up together!"

The name of S. A. Andree, the Swedish engineer, is famous for his attempt to reach the North Pole by means of a balloon. But had he never gone to seek death or glory in the frozen north, he would have been entitled to our notice for his wonderful aerial voyage across the Baltic Sea in October of 1893. He had ascended for purely scientific purposes on the 19th of that month, and in making his descent found to his horror that he had drifted out to sea, where his fate was certain unless he could reach Finland or fall in with a vessel. He did sight a steamer, but the captain, afraid of an explosion if the balloon came near his fiery funnels, put out all fires, and so could not move to Andree's assistance. In this critical condition the aeronaut maintained perfect possession of himself, and now determined on reaching Finland.

The wind greatly increased, the balloon sailing on at eighteen miles an hour, often dipping towards the water, but never touching it. To prevent that danger, Andree cut away the anchor which he had been unable to raise—a desperate expedient. At dusk he was flying over the cliffs of Finland, but the wind changing, blew him along the coast. The remainder of his extraordinary voyage is best told in his own words :

“For ninety minutes I was standing on the edge of the car, with some ballast in my hands, ready to throw it out in case of danger of collision with a cliff. Suddenly I saw a sharp light. I supposed it was a lighthouse ; but there appeared now two, then three lights ; it was evidently a building. For one moment I lost my presence of mind and failed to grapple the rope to the ventilator and hang on to it with all my powers. Now it was too late. I had passed the island, and the balloon came down into the water. I was lying in the bottom of the car, and the water rushed in with such force that I could not move. Most of the way to the next island I was under water.

“But this could not continue. At length, after much turning and twisting, I succeeded in getting my legs over the edge of the car, just when the balloon swept over the next cliff. It was a wonder I escaped without having them broken. I tried several positions, but the car was so unsteady that I was never safe ; but I could not endure it much longer. I felt myself so feeble that it would have been an impossibility for me to try to hold the

balloon. I had only one course now to pursue—to save my life. Passing over the next cliff, I jumped down. The balloon shot up in the air and disappeared.

“I was saved ; but, alas ! in what condition and for how long a time ! I had hurt my leg in falling, and could not stand, so I crept round the cliff in search of shelter ; but none was to be found. It was now between seven and eight o’clock. For a couple of hours I shouted aloud, in the hope that I might be heard by some passing boat ; but the raging storm took away the sound of my voice.

“I then turned my attention to making myself as comfortable as possible for the night, though the prospects were anything but pleasant. I was wet through, my fur cap had blown away, and I had nothing to put on my head. This made me specially anxious, because my only chance of being rescued was to keep my head clear. I made a cap of some handkerchiefs and lay down on the cold ground, hungry and shivering, trying to keep up my courage if not my temperature. So passed the long night.

“At length day dawned. I was now able to stand, and, with my glasses, which I had fortunately round my neck, I saw in the distance the island over which I had passed the night before. In order to draw attention to my position, I took off my trousers and waved them in the air. Shortly afterwards I was glad to see a boat sail out from the island and steer straight for the place where I lay.

“I soon saw they had not set out in response to my signal, for the men never once looked in the

direction of the cliff, and the boat passed me. I shouted myself hoarse ; but in vain. I began to look about to see if I could make a raft out of the few trees there were ; but as I had neither axe nor knife, I was obliged to give up the idea.

“When I returned to my sleeping-place, I found a boat close by. A man on the island had seen a big square boat, with an enormous sail, come sailing from the sea with a terrific sweep, and go flying over the ground, and again disappear in the sea. This was my balloon, or, rather, his description of it, for the islanders had never seen anything of the kind before.

“His curiosity was aroused, and early in the morning he went down to the beach with his glasses to see if he could find out what the strange apparition could have been. He then saw my signals and put off to my rescue. I was quickly taken over to his home and well cared for.”

But, as we have said, it is his attempt to make an aerial voyage to the North Pole that has rendered his name a familiar one throughout the world. His balloon was called the “Eagle,” and resembled the ordinary aerostat, save that it also carried a sail ; and the car, made to accommodate three persons, had a comfortable sleeping apartment, the roof of which served as a deck. Danskoë, in Spitzbergen, was the place selected to start from. The balloon was inflated there on July 23rd, 1896, but two months passed, the winter came, and the adventurers had waited in vain for a favourable wind. On July 11th, 1897, Andree and one companion, Strindberg, re-

turned to Danskoë, and soon were favoured by a south wind, borne by which the "Eagle" sailed away into the unknown.



THE "EAGLE," IN WHICH ANDREE SET OUT FOR THE NORTH POLE.

It was a strange, bold scheme, and by no means so mad as some people thought. But nearly five years have passed and the voyagers have never

returned, though countless reports about them, never quite authenticated, have been circulated from time to time, the latest coming from Kanakee, Illinois, to which town, it was stated, two citizens had returned late in the autumn of 1901, from a tour in the Hudson Bay territory, and according to a report alleged to have been made by these gentlemen, certain Indians in the spring of the previous year found the bodies of two white men and the basket of a balloon at a spot 900 miles north of the Moose River. The description of one of the bodies given to the Illinois tourists by the Indians tallied with that of Andree.

Of contemporary English balloonists the Rev. J. M. Bacon and Messrs. Stanley and Perceval Spencer bear the best-known names, and each has had many interesting experiences. They are, of course, devotees of the old art of ballooning as distinct from the modern attempts to perfect the airship. Mr. Bacon, who has been felicitously described as "a real sky pilot," has been engaged in aerial experiments for upwards of fifteen years, and has described in his interesting little book, *By Land and Sky*, many of his adventures, in which his daughter, Miss Gertrude Bacon, has occasionally been a participator.

Mr. Bacon has made frequent night ascents, and has enjoyed several times that rare spectacle which gas-lit London presents to the aeronaut who floats above it in the blue night; even having had the temerity to explode some bombs when passing over Trafalgar Square last year! It is interesting to note, by the

way, that, according to Mr. Bacon's experience, a cartridge suspended 120 feet below the car of a balloon and exploded by electricity is followed by a report no louder than a pistol shot to the ear of those in the car; but presently this is succeeded by a terrific noise, caused by the earth returning the sound into the air.

Mr. Bacon, as we have had occasion to remark before, has not practised ballooning merely for the sake of adventure, but has carried out many useful experiments relating to certain departments of scientific research, with which for the present we are not concerned. But we must mention at least the results of one of his most recent voyages, from Fulham across London to Ashford, lasting three hours—from 3 till 6 a.m.—on August 16th, 1901. This was, for various reasons, an important little journey. In the first place the ascent commenced after pilot balloons had been floated for the purpose of indicating the direction of the air-currents, and Mr. Bacon found no difficulty in conversing with many people in the streets by means of the ingenious acoustic instruments which he has invented. He also succeeded in conveying messages to telegraph operators by using a huge black collapsing drum, which, by contraction and expansion, was made to indicate the dots and dashes of the Morse code. All his experiments were most successful.

One of the most interesting of Mr. Bacon's journeys is thus described by Mr. Swinbourne, who accompanied him:

"At half-past nine to the moment, with a hearty

cheer from the little crowd of onlookers, the balloon was freed, and in a minute or so we were at a height of 650 feet, and finding ourselves, curiously enough, considerably warmer than we had been on *terra firma*. Away behind us lay London, lanes and lanes of sparkling light ; but to make out special localities was not easy, although we could readily distinguish the flash-light of the Belvedere Tower at Earl's Court Exhibition. At 1,000 feet high we were over some suburban railway station, and the sight of a train rushing along a curved cutting was not one to be forgotten. It was like a comet, with a fiery gold head and a silver tail. The moonlight on the trail of smoke made it look like the rapids of a river in moonlight—a rushing mass of silver water. The engine was a glow of fiery red—you saw no train. At 2,000 feet it was marvellous to note the clear-cut shadow of the balloon which the moon gave. As we threw out sand, its shadow could be seen dropping from the balloon, first in a broad stream, then, as it disintegrated and the particles separated, widening into a nebulous shade, to disappear altogether as it dropped earthwards. Mr. Bacon and Mr. Perceval Spencer both assured me that the balloon's shadow thrown was far more distinct and sharply defined than during voyages by day. The night, in truth, was a perfect one, and until then I had never known what moonlight could be. Every roadway, hedge, and rivulet stood out as clear as if we were looking down on a huge scale map. At 2,500 feet we were moving very slowly, passing at the moment one of the most striking of

the many picturesque effects the night afforded us, as we crossed the Medway right over the Pottery Works at Aylesford. The blazing furnaces gleaming below, encircled by the tortuous silvery winding of the river, offered a superb *coup d'œil* under the moonlight."

But the most remarkable of all Mr. Bacon's aerial voyages was that which he undertook some years ago, when all England was looking for the November leonides which never arrived. Accompanied by his daughter and Mr. Stanley Spencer, Mr. Bacon started from Newbury at four o'clock on a raw November morning, in the hope of seeing the leonides on their native heath, so to speak. If their quest after the errant meteorites was unsuccessful, they at least succeeded in finding abundance of adventure, for the ascent proved one of the most memorable in Mr. Bacon's experience.

To understand what follows it is necessary to explain that the balloon was a hermetically sealed one, this being necessary to prevent loss of gas, as they desired to remain in a high position for many hours. There was an arrangement for ripping the cover when ready to descend, but as Mr. Bacon wished to rise to a good height they were soon far above the clouds, and many hours passed without a peep of the earth beneath. Up there in the cloud world they floated about amid chilly vapours, and when the dawn brought with it the rays of the sun, these were found to be almost unbearably hot. For hours the balloon travelled on, and its occupants could form no idea of their locality owing to the fantastic tricks

of the clouds, but a little before noon the shriek of an engine, and the rumbling noise of many trains, suggested they were over some important railway centre, while the sound of hammers indicated a busy hive of industry. Mr. Bacon concluded from these signs that they were being carried over the city of Bristol, and the fear of a possible disaster in the waters of the Atlantic at once rose up before him. Still they could not risk ripping the balloon, as they could see nothing beneath them but cloud.

At this juncture Miss Bacon conceived the idea of sending some messages down to earth telling of their danger. Three dozen telegraph forms were hastily written and thrown out: "URGENT—Large balloon from Newbury travelling overhead above the clouds. Cannot descend. Telegraph to sea (Coast Guards) to be ready to rescue." Only one of these missives was subsequently traced in its flight from the balloon. It was found on a mountain side near Pontypridd and must have occupied nearly two hours in falling.

An opening in the cloud floor showed land beneath, and they immediately ripped the balloon and commenced their descent. A gusty wind driving through the valley into which they were descending made the operation no easy matter, and the three aeronauts were all very much bruised, Miss Bacon having an arm broken by the shock of their impact with Mother Earth. They had landed near Neath, only a mile and a half from the Atlantic, into which they would certainly have drifted but for the lucky rift in the clouds. The voyage had occupied ten hours,

and by virtue of that fact established a "record" in British ballooning.

Mr. Stanley Spencer has made many ascents from the Crystal Palace and is a member of the well-known firm of balloon specialists, but he has never had so notable an exploit to recount as that which comes within the experience of another member of the same family—Mr. Perceval Spencer. The Spencers, by the way, are descended by marriage from the famous Charles Green, the father of modern ballooning.

Some years ago Mr. Perceval Spencer had arranged to make a balloon ascent from Calcutta and to come down in a parachute. About two thousand people had turned out to witness the performance of the young aeronaut. Lord Lansdowne and many prominent government officials were present, to say nothing of native princes and their retainers. The ascent was to be made with a simple balloon without a car, the parachute being so attached to it that it could be easily freed for the descent. To the chagrin of the aeronaut it was found that the balloon had not sufficient lifting power. Some days previously an enormous crowd had assembled to witness him ascend, and a hitch having then occurred the performance had been postponed. The prospect of a second postponement was again before Mr. Spencer, and he determined that the crowd should not be disappointed again.

Greatly daring, he had put his quickly formed resolution into act before any one had realised what he was after. The balloon sprang upward with the

aeronaut sitting on the sling rope, and absolutely lacking every item of apparatus usually considered indispensable for the most ordinary ascent. His parachute was left lying on the ground.

The sequel is told in the words of a recent writer in *Pearson's Magazine* on "Skippers of the Sky": "The crowd simply gasped in amazement and horror, as, with strained vision, they watched the ball, now dwindled to a child's plaything, with what looked like a tiny insect suspended beneath it. Away it went, till at last it melted into the blue haze, and was lost to vision. No one expected ever to see Mr. Spencer again. He was regarded as good as dead, a victim to his own rashness, which all condemned, though they could not but admire.

"Three days passed, but without tidings of the unhappy balloonist. Not the slightest doubt was entertained of his death, only the probable manner of it was subject for endless conversation and newspaper paragraphs. Then the Press proceeded to decently inter him, with columns of mournful obituaries. The last swan-song was sung over the fate of the gallant and infatuated young Englishman, and the matter was regarded as closed, when lo! on the third day Mr. Spencer returned to Calcutta as if from an ordinary Saturday - to - Monday vacation, and wanted to know what all the fuss was about.

"His adventures read like a chapter out of *Sinbad the Sailor*. His flight from Calcutta had continued for several hours, during which time he covered a distance of some forty miles. Like an uncanny bird, he flew over jungle and plain until, literally wearing

out the strength of his aerial steed (to change the metaphor), he alighted, to the dismay and astonishment of the natives, on one of the islands formed by the delta of the Ganges. Of course, he might just as easily have fallen into the Ganges itself, and become food for the crocodiles. Being without a valve, his balloon might have risen beyond the point that respiration is possible. But none of these things happened."

The latest passage across the channel, like the first of all, was accomplished by a Frenchman, M. George Latruffe, at the end of November, 1901; ascending from Dunkirk at 1.45 and landing at Southminster at eight o'clock the same evening. M. Latruffe thus describes his experience :

"I made the ascent at the conclusion of the festivities in honour of the Czar, intending to reach Dover about five o'clock. The weather was extremely favourable, and a brisk breeze blew in the right direction. I had a beautiful send-off. For some miles I kept in a direct line for Dover. Suddenly the wind veered round and I was carried further north, and I soon knew that I should not reach my objective. I passed near Margate just as it was getting dusk, and I had hopes of being able to land somewhere there, but the wind took me out to sea, and for a long while the course was zigzag.

"At one time the balloon descended so near the water that I was able to speak to a passing steamer, but apparently no one on board could speak French, and so I could not get any reply. Later, I got within speaking distance of another vessel. By

this time it was quite dark. 'Where am I?' I shouted. Just then my balloon suddenly ascended, and the only words I could hear in reply to my question were, 'Vous êtes trois——' ('You are three——'), the remainder of the words being quite lost in space.

"I drifted on and on further north, and at length came to a large town showing many brilliant lights. I think it was Clacton or Brightlingsea. As I passed near the coast I blew a whistle several times and listened for a response, but none came, and all was quite still. I was very hopeful of effecting a speedy landing, when I was startled to find that my balloon was being blown right out to sea again. Of course, I recognised the danger, and fastened a life-belt round my waist, lighted a cigarette, and sat back in the car waiting anxiously and patiently for a favourable turn of the wind. It soon came. The course described from this point was almost a big circle, which eventually brought me off the Essex coast.

"Then I sailed over Foulness Point and across four miles of marsh-land, and, looking through my glasses, I saw a favourable place to descend. I dropped the grappling iron, which tore slices off the top of three hay-stacks and then held firmly in an oak-tree. The balloon came gently to the ground, and I jumped on to firm soil minus my hat and a medal, both of which were lost in the sea. Three residents kindly came to my assistance, and we packed up the balloon and went to the hotel.

"What a sensation I caused in the village! Just think. I could not speak a word of English. I looked like—I do not know what I looked like! I was

dripping with perspiration, I was bareheaded, and I had a life-belt round me, and I had to walk like this amid a throng of astonished villagers. They must have exclaimed, 'He is mad.' But they all treated me very kindly, and even went to the extent of searching for people who could speak French. Three came forward, but, alas ! I could not understand one of them. I must learn English."

This admirable little voyage attracted not one tithe of the attention aroused in the preceding month by Count de la Vaulx's attempt to cross the Mediterranean in a balloon. The Count de la Vaulx is the young aeronaut who, in 1900, made the first balloon voyage from Paris to Russia.* His Mediterranean exploit was an important one in many ways, having for its object the testing of a new device called the deviator, and to experiment with wireless telegraphy. It was also hoped to prove the feasibility of communicating with Tunis or Algeria in case of a blockade of these ports. The balloon was spherical in shape, holding 3,000 cubic metres of hydrogen gas, but having inside a small balloon filled with air.

The most important features of "La Méditerranéen," as the balloon is called, are the *stabilisateurs* and deviators. These inventions are thus described :

"Vertical stability is the life of a balloon ; continual mounting and descending means continual loss of both gas and ballast. The *stabilisateurs* are heavy flexible cables. Their chief characteristic is their high degree of tautness, which comes from their considerable weight in relation to the *metre* of distance

* See Chapter IV.

to be passed over, and also their slight resistance to the forward movement. Such an apparatus, according to its greater or less immersion in the sea, ballasts or unballasts the balloon, whose basket is thus kept from contact with the waves, floating above them at the same distance in spite of gusts. On the other hand, the great power of the apparatus permits the balloonist, when he wishes, to correct, by automatic variation of the cables' immersion, all vertical unbalancing. The deviators are veritable instruments for partially directing the course of the balloon. The Hervé deviator is formed by a series of parallel concave plates, fixed two by two by rigid steel plates in such a way that the whole series can be bent by a simple movement. The deviator is connected with the balloon by two steerage cords. As long as these two cords are of the same length, there is no change in the direction, and the apparatus acts like a strong floating anchor. But if one of the cords is shortened, the plates of the deviator turn obliquely, and the whole series rapidly changes position and tows the balloon to right or left. This latter apparatus permits a change of direction to any point situated under the wind within sixty-five or seventy degrees to right or left of the balloon's direction at the moment. It is, after all, nothing very different from a ship's steering gear applied to a balloon that hangs over the water. Like the *stabilisateur*, it presupposes that the balloon shall not soar into the higher air, but float comparatively close to the surface of the sea. This is another novelty of the new ballooning, whose ideal it is to

go *plane-ing* along great stretches of distance, without loss of gas or ballast. There is always time to dart into the upper air when occasion requires it."

At midnight on Saturday, October 12th, the much-talked-of voyage commenced. On leaving Les Sablettes, near Toulon, the "Méditerranéen" met an easterly wind that carried her out of her course, which was a southerly one. The breeze was gentle, and the *Du Chayla* (a cruiser which had been sent to render assistance in case of need) easily kept pace.

On Sunday the mail steamer from Algiers exchanged signals with Count de la Vaulx, then fifty miles from Marseilles, when he reported "all well"; but the next night, when about ten miles to the east of the St. Laurent Lighthouse, near the Pyrenees, the count made up his mind that there would be no change of wind, and that he must give up his attempted trip to Algiers. He signalled to the *Du Chayla*, and alighted safely on her deck, the balloon being stowed away on the forecastle.

The whole journey had lasted forty-one hours without any hitch, and on returning to Toulon the count made the following statement:

"Although we have not attained the object of our journey we can express satisfaction with our experiment, which has given excellent results, and has permitted us to ascertain that, owing to the Hervé apparatus, it is possible to remain in a balloon over the sea for several days, and we fully intend to recommence our experiments some day or other with a still more perfect apparatus."

So ended the latest attempt to accomplish a long

voyage in an aerostat. But it is the glory of ballooning that failures only spur on to renewed efforts; and with M. Goddard, the famous Paris balloon-maker, at work on a great balloon of 11,000 metres in which he means to attempt the crossing of the Atlantic, and Mr. Samuel A. King, a well-known American balloonist, promising, with much confidence, a similar attempt from the other side, it is evident we are at the beginning of a new and wonderful era in the history of aerial travel.

CHAPTER IV.

A Race through the Clouds—Long-Distance Records—From Paris to Russia—Count de la Vaulx's Famous Victory.

WE have purposely omitted from our preceding chapter all mention of the great balloon race from the Paris Exposition of 1900, as it seems to us that the story of that unique event is deserving of a chapter to itself. Since the earliest days of the world's history races of all kinds have had a strange attraction for man. The Romans had their chariot races, and we know, to our national sorrow, that we have our horse races. But surely a balloon race must be regarded as an exception to Solomon's rule. It may be asserted, with some confidence, that never before had such an event taken place. Think of the audacity of the idea! A race through the clouds! Even the struggle for the America cup lacks excitement compared with that.

This great aerial contest took place at the beginning of October, 1900, and was regarded as the most remarkable feature of the exposition. Many notable French aeronauts entered for the prizes that were offered, and the conditions of the race debarred all forms of aerostats other than the ordinary balloon from competing. Although the rules and regulations,

with characteristic French volubility, filled fifty-eight pages of small type, the conditions were simplicity itself. There was to be no handicapping, each competitor was free to use a balloon of any shape or size, to carry as much ballast as he cared for, to avail himself of as many fads as he fancied, and to make use either of hydrogen gas or the ordinary carburetted kind, according to the length of his purse. These conditions were liberal enough to produce the best and most interesting results.

There had been a number of preliminary races of a trial nature, but the two principal events were fixed for September 30th and October 9th. The former date was a Sunday, and on the Vincennes Field many thousands of Parisians had turned out to enjoy the novel spectacle—novel even in that godless city of sensations. The scene was a curious one, touched at first with some degree of dulness, for there is nothing very exhilarating in watching a dozen shapeless masses of canvas and silk lying on the ground, and slowly distending as the gas is introduced into them. But gradually, as the balloons begin to take shape before the eyes of the spectators, interest awakens, and the jaunty aeronauts who move about superintending their flimsy crafts become objects of much curiosity. These are the men who are going to brave unknown dangers in the skies, and your Parisian is ever full of admiration for those who seem to be doing something suggestive of heroism.

The baskets are now being attached to the swaying balloons ; ballast, scientific instruments, food—no

Frenchman is ever wanting there—are placed in the cars, and presently the dauntless competitors themselves are seen gracefully bestowing themselves inside the wicker-work, each as conscious of his dignity and his great *rôle* on the world's stage as if he were Napoleon himself. The aeronaut examines all the arrangements, counts his bags of ballast, is satisfied that all is well. The official judges, oozing importance and authority at every pore, are present. The moment for which the good-humoured crowd has waited so patiently is at hand. Workmen skilfully detach the sand-bags which are weighting the balloon to earth, the mooring rope is severed at a slash, and a mighty cheer bursts from the crowd as the first aerostat bounds upward into space, catches a breeze blowing north-east, and speedily disappears from view, dragging its tiny car beneath it.

It is the "Conte" that has just set off, and the two gentlemen who have waved a theatrical adieu as they mounted into the sky are civil employees of the Meudon University. Five minutes later the "Urania" shoots into the heavens. Captain Vernanchet sits in its car, shaped like a boat and painted red. He has a burlesque steering apparatus in the bow, and at the stern is an umbrella, which he works violently as though he were sculling his boat over a celestial sea. Cheers and hilarious laughter greet the operation, for this is the gallant captain's little way of protesting against the decision to exclude steerable balloons—so-called—from the competition.

The crowd is now in ecstasies of delight, for every five minutes another balloon pops up and is borne

away in the north-east wind. The third to go is M. Jacques Faure, and his balloon is called the "Aëro Club." The fourth is the famous "Centaure" in which the young Count de la Vaulx has already established long-distance "records." As he rises now, bowing, cap in hand, to the multitude, he is greeted with cries of "Vive la Russie !" Prophetic cries ; for the north-east wind has caught him in its embrace, and is hurrying him towards the kingdom of the Czar. See how the heavens favour the Franco-Russian alliance !

"Here is a veteran of more than thirty ascents during the last year and a half," said an expert as the "Centaure" rose in the air—"a fatigued and well-worn veteran which has been ripped open in many a landing, covered with wounds hastily patched up, made heavy by successive revarnishings and repairs. It is a balloon of medium size, having a disposable ballast of only 1,760 pounds. It is a cheap construction, too, a simple cotton affair that costs scarcely more than the price of a voiturette, and yet it goes farther, quicker, and more certainly than its more costly rivals. Why, I do not know. Born under a lucky star, I suppose. But what a delightful way of travelling ! In a day and a half by balloon we cover a distance which it takes nearly a week to return by train, with all the jolting, the cinders, the frontiers, the bad meals, the customs annoyances. Ah, there is nothing like ballooning !"

The fifth balloon to get away is the gigantic "St. Louis," the capacity of which is 3,000 cubic metres. Her captain is M. Jacques Balsan, another of the

gilded youth of Paris who have found a new sensation in ballooning. He carries two passengers with him. In quick succession follow the remaining seven balloons, signalled by volley after volley of cheers. The boulevards hum that evening with talk of aeronautics. In materialistic Paris it is seldom that one hears so much about the heavens; rarely do the thoughts of the populace mount even as high as the "Centaure."

Next afternoon excitement is renewed as the telegrams come in, telling of the fortunes which have attended the various competitors. Two have landed in Holland, one has come down in Westphalia, four have not got out of France, and the humorous "Vernanchet" only got a little way out from Paris. One had arrived on the edge of the Baltic, after a voyage of 496 miles, lasting fourteen hours. But this was nothing. The "Centaure" had done that and better already. Nor did M. Faure accomplish a wonder by travelling to Mamlitz in eastern Prussia, 753 miles away. But there still remained the "Centaure" and the "St. Louis" to account for, and soon the news came that the former had descended near Wloclaweck, in Russian Poland, having made the journey of 766 miles in twenty-one hours thirty-four minutes, while M. Balsan's balloon had come down in eastern Prussia, near Dantzic, 757 miles away, in twenty-two hours. Count de la Vaulx was the winner, with Balsan second, and Paris went mad with joy over the first balloon voyage into the country of France's "ally."

"I could have gone some distance further," said

de la Vaulx himself, on his return to Paris a few days later, "as I had on hand more than 200 pounds of ballast. But I was afraid of getting so far into the interior of Russia, away from the railways and telegraphs, that I could not get back in time for the next race. So I decided to land. It was well I did. Though they had the telegraph at hand they kept me in gaol for twenty-four hours, till my case could be officially investigated."

The opening of the aerial route, "from France to Russia," as the Parisian Press put it, created immense excitement among a people who are easily excited, and the final balloon race on October 9th was a scene of even more remarkable enthusiasm than that which we have just described. There were six competitors. The Count de la Vaulx was the only one who used the expensive hydrogen for inflation, and he was accompanied on this occasion by the Count de Castillon. But the hydrogen generator did not work effectively, and after some hours of effort he was fain to pan out with ordinary gas.

The results of the final race left the two who were first in the previous race again in the same relative positions. Here is the official record of the event:

First—M. le Comte Henri de la Vaulx, descending, after thirty-five hours and forty-five minutes of voyage, at Korosticheff, in Russia, travelled a bird's flight distance of 1,925 kilometres (1,193 miles) from the point of departure. Maximum altitude, 5,700 metres (18,810 feet).

Second—M. Jacques Balsan, descending near

Rodom, in Russia, after twenty-seven hours and twenty-five minutes of voyage, travelled a bird's flight distance of 1,360 kilometres (843 miles) from the point of departure. Maximum altitude, 6,540 metres (21,582 feet).

The other contestants had made distances varying from 550 to 950 kilometres.

Count de la Vaulx was naturally the hero of the hour in Paris, for had he not broken all aeronautical records, both for length of journey and duration of voyage, and landed twice within a fortnight in Russia, and was he not a Parisian?

Mr. Walter Wellman has been able to publish some interesting extracts from the "log-book" of the "Centaure" and from his excellent magazine article on the subject we take the following particulars. In his log-book Count de la Vaulx confesses that his craft was filled with 1,400 metres of hydrogen and only 200 metres of illuminating gas. At the start it lifted a total weight of 1,485 kilogrammes, thus apportioned: Weight of balloon, car, and appurtenances, 540 kilos; passengers' weight, 145 kilos; weight of instruments and oxygen tubes (the latter for respiration of the travellers at great altitudes), forty kilos; sand ballast, 775 kilos; ballast in provisions, twenty-five kilos. At 7.20 p.m. the log contains this entry: "Fine night—used sixth sack of ballast." At 8.20: "1,500 metres altitude; course E.N.E. We are above the fog." At 8.40: "We have finished dinner. A balloon is following us." At 9.10: "1,600 metres; good equilibrium. Over large city." At midnight: "Passed to south of Ponds of Bairon." At

12.10 a.m. : "Traversing the Ardennes Canal." At 1.40 : "Little inhabited country." At 2.15 : "The fog mist forming rapidly, we, mounting with it, see the earth no more." At 3.20 : "Thick mist all around us. Used eighth sack."

After day had fully come a note says : "We are in a mountainous country, Bavaria, without doubt ?" The entry ends with a mark of interrogation, nevertheless. "This," said de la Vaulx, descanting upon the joys of ballooning, "is the charm of the whole thing. The balloonist becomes an explorer. Say you are a young man who would like to roam a little ; you want adventures ; you want to penetrate the unknown. But you are tied down at home by family, business, whatnot. Well, you take to ballooning. At noon you have luncheon with your family. At two o'clock you ascend. Fifteen minutes later you are no longer a commonplace denizen of the easy-going town—you are an adventurer into the unknown, an explorer as surely as any who melt in Africa or freeze in the Arctic. You do not know any too well where you are at any given moment, and as for knowing where you are going, or when you are to get there, why, that is all a guess. See how amusing it may be ! It is principally chance and the winds. Yet you have something to say about it too—something depends upon you, your skill, your nerve, your wisdom, your experience. Then, when you decide to come down, it is really jolly to speculate upon what country it may chance to be, what language the people speak there, and how they will receive you."

This mad race through the clouds continued all day (writes Mr. Wellman in *The Idler*). The two ships of the air were flying, neck and neck, over southern Germany and Bohemia. In the early morning the rivals began a series of competitive manœuvres—the yachtsmanship of the atmospheric ocean. When the “Centaure” threw out ballast and rose above the mist clouds, the “St. Louis” followed suit. When the “Centaure” let out a little gas and descended nearer the earth, the “St. Louis” lost no time in executing a similar movement. So near together were the racers at one moment that de la Vaulx and Goddard in their respective balloons were able to make out the identity of their competitor. At nine o’clock they passed over a large city, but they could not guess its name. In an hour they passed another town, also a wide river, and still they did not know where they were. “Balsan is always mounting,” says the “Centaure’s” log-book; “he has passed in front of us, and is working more towards the south. This continual mounting,” it is recorded with evident satisfaction, “will doubtless shorten his trip.”

At two o’clock in the afternoon the sun was clouded over, and the balloon suffered such a great condensation that they were compelled to throw out several sacks of ballast, and even at that fell near enough the earth to have a good view of a large city, which they thought was Posen. “Our rival has also descended from the high altitudes,” says the log, “and appears to be going with his guide-rope.” Later in the afternoon the wind became more violent; there were only six sacks of ballast

remaining ; but as the country appeared to be one of plains, they decided to pass the second night in the air. "Our rival has disappeared," notes the log-book of the "Centaure," with an air of triumph and finality.

M. Goddard, the famous aeronaut, who accompanied M. Jacques Balsan in the great "St. Louis," has also given an intensely interesting account of the race from his point of view, and this is worthy of being placed on record along with the victor's story. M. Goddard says :

"During the night we were busy trying to keep our equilibrium, going neither too high nor too low, and wondering where our rivals were. At seven o'clock next morning we were over Coblenz, and had already made 500 kilometres. At eight o'clock the influence of the bright morning sun upon the volume of gas in our big balloon carried us very quickly to a height of over 4,000 metres. A few seconds later we were delighted to sight the 'Centaure' but a little ahead of us, and running in a course parallel to ours. This was a race indeed ! All day we were able to travel together, each of us undergoing, in proportion to our volume of gas, the alternations of dilatation and condensation. Little clouds, masking the sun, instantly reduced the volume of our spheres and compelled us to throw over ballast.

"When the sun came out again it warmed the great balls of gas, and so added to the volume by dilatation that several times we were compelled to let out gas in order to escape rising to a dangerous

altitude. Late in the afternoon both balloons had risen to between 6,000 and 7,000 metres, which was quite as high as any of us cared to go. Before we descended to a lower level we saw the 'Centaure' far below us, manipulating its guide-rope along the surface of the earth. Suddenly our rival shot up rapidly, and we saw no more of him. We were now in the neighbourhood of Breslau or Posen, and we were made very sad by the disappearance of our ballast, of which only about ninety kilos remained.

"Night was coming again, but we were determined to stay afloat as long as possible. As we passed over the German-Russian frontier four shots were fired at us, probably by customs inspectors who thought we might be smuggling. We heard the whistle of the bullets, but fortunately the 'St. Louis' was not hit. Just before dark we were making splendid speed; our instruments showed seventy kilometres per hour due east. We sighed for more ballast. But now, behind us, we could see a tempest forming, with lightning and thunder. We had only thirty kilos of ballast left, and if the rain should overtake us our balloon would absorb thrice that weight of water, and we should be carried down to earth whether we wished or not, and probably in the most awkward of spots. We had no desire to descend in a forest, and so we began spying out, as best we could in the thick of the storm, a clear space in which to alight. One appeared just behind a forest. M. Balsan pulled the valve rope, and, despite the violence of the wind, the 'St. Louis' came to the ground gently and with only five metres of dragging. Some

peasants came running up, and one of them we sent for a waggon, while the others aided us to empty the balloon of the remaining gas—only 1,300 or 1,400 metres cube were left out of the 3,000 with which we had started—and by midnight we had arrived at a village. We were given milk and black bread to eat, and a hayloft to sleep in.

“Next morning, early, a good-natured gendarme roused us with the explanation that, as we had no passports, he was compelled to escort us to the police authorities at a neighbouring town. The police, amiable but firm, declined to let us go without orders from their superiors, and it was nine o'clock that night before the telegraph brought permission for us to return to Paris.”

Such is a fairly comprehensive record of one of the most remarkable episodes in the annals of aerial navigation; and we pass now to the consideration of the progress made in the construction and direction of airships as distinct from ordinary balloons.

CHAPTER V.

The Exploits of Señor Santos-Dumont—The Principle of his Airships—First Round the Eiffel Tower—Shipwrecked in Mid-air.

SINCE the far-off days when Montgolfier first discovered that a balloon could be made to rise into cloudland by means of heated air, it is doubtful if there has ever been such a sensation as that occasioned by the efforts of Señor Alberto de Santos-Dumont to win the Deutsch prize by steering a balloon from the grounds of the Aëro Club, at St. Cloud, round the Eiffel Tower and back to the place of starting in thirty minutes, an aerial journey of over seven miles. Indeed, it may safely be said that no such sensation has ever been occasioned in the history of aeronautics ; for in the early days of the art there did not exist that world-wide system of telegraphy and the Press, which has enabled people in the remotest quarters of the globe to follow with deep interest the exploits of this most daring of modern aeronauts.

It is a curious coincidence—perhaps more than a coincidence—that Señor Santos-Dumont is a Brazilian, like that pioneer of aerial navigation, the monk named Bartholomeo Lourenco de Gusmao, who, early

in the eighteenth century, made an ascent from Lisbon in an extraordinary airship, which has been described at some length in our opening pages. Indeed, Gusmao actually hailed from the State of St. Paulo, of which Señor Santos-Dumont is also a native. But while the enterprise of Santos-Dumont has been splendidly rewarded, the efforts of his far-off countryman were recognised, as we have heard, by death at the hands of the Inquisition.

The luckier Santos-Dumont was born at Rio de Janiero in 1873, so that he is still quite a young man. The youngest of a family of ten sons, his father, who was of French descent on his mother's side, is a wealthy coffee planter and is known, indeed, as the Coffee King, employing six thousand labourers, and having over forty miles of light railways on his estate. This coffee planter being himself a man of culture, and having graduated at the famous Engineers' School at Paris, encouraged the mechanical bent of the mind of young Alberto, who, when only twelve years of age, was fond of driving his father's steam-engines. It was due, no doubt, to this early experience and his life-long fondness for mechanics, that Alberto acquired the knowledge which has enabled him to inaugurate a new era in scientific ballooning.

In 1897 young Santos-Dumont came to Europe, and, like all wealthy Brazilians, was naturally drawn to Paris. It is not stated whether he had attempted any aerial flights in his native Brazil, but there can be no doubt that he was strongly fascinated by the art before coming to Europe, though his first ascent in the old world was the rather commonplace

climb of Mont Blanc ; made, of course, on foot. But in 1898 he was the possessor of the tiniest balloon ever made for carrying a man aloft—a mere toy affair indeed.

It was named the “Brazil,” and was made of the lightest Japanese silk, having a capacity of a little over 3,000 cubic feet. His first ascent in the car of this little balloon took place from the Jardin d’Acclimatisation, and a few months later, in September, 1898, we find him in possession of his first steerable balloon or airship, the motor of which had been taken from a motor-tricycle and its power developed by petroleum. His initial attempt to soar aloft was a complete fiasco, the balloon being torn beyond repair, but with proverbial good luck the young aeronaut escaped without hurt. Since that time he has made no less than seven flying-machines, each one showing some improvement on its predecessor.

The general principle of all his aerostats has been the same—a compromise between the balloon and the flying-machine. His latest airship, “Santos-Dumont VII.,” is about twice the size of its predecessor, in which he twice rounded the Eiffel Tower. That is to say, the cigar-shaped balloon is some two hundred feet in length and rather more than twenty-four feet at its greatest diameter, holding over 30,000 feet of gas, and having a lifting capacity of nearly one ton. The envelope, which is made of finest *soie de Chine* is inflated with hydrogen-gas and encloses two small air-balloons, which help to give rigidity to the larger envelope. There is no framework in the balloon ; pressure of the gas alone keeps it rigid.

The car or frame-work, which is hung beneath the balloon, is entirely the invention of Señor Santos-Dumont. It consists of three long triangular rods held together by a series of triangular braces and pointed at the ends after the manner of the balloon itself. The triangular section offers least resistance to the wind. Between the third and fourth braces from the prow—if we may use the term—is situated the wicker-basket in which the aeronaut takes his stand and where all the complicated machinery for controlling the motors and the helm are placed.

Amidships are the two powerful motors, each of forty-five horse-power, which is an enormous difference compared with the sixteen horse-power motor of the "Santos-Dumont VI." At the stern, and connected with the motors by means of a hollow shaft, is the propeller with its two great blades of skin stretched over wire frames; and above the propeller rises the mighty rudder, somewhat similar in its construction, the cords for moving it stretching to the aeronaut in the basket. The forepart of the frame is weighted with several water-vessels in order to balance the whole.

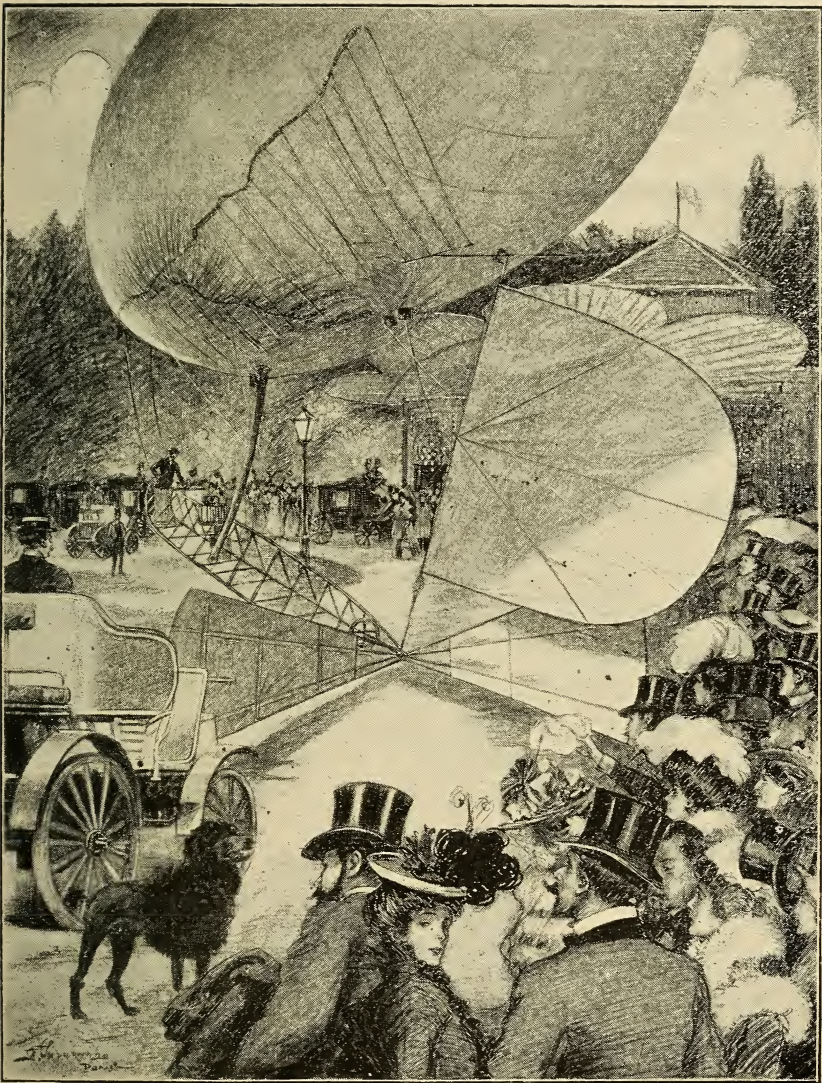
It is claimed for it that the method of keeping the cylinders of the motors cool is the secret of Señor Santos-Dumont's success. This is effected by means of a refrigerator, which consists of a *ballonet* and a ventilator.

The whole framework—we can scarcely call it a car—is hung to the immense gas-bag with piano wires fixed in a series of eyelets. These wires look as fragile as thread, but each is capable of supporting three-quarters of a hundredweight, and as there are

many hundreds of them there need be no fear on that score. When running at high speed these wires hum like an Æolian harp. "Santos-Dumont VII." has a speed of forty miles an hour.

It is estimated that this most famous of all the navigators of the air has spent upwards of £25,000 on his series of airships, and some slight idea of the costliness of constructing the balloon portion alone may be gained from the following description of the making of one of his silken envelopes :

"It is made of beautiful Japanese silk, fine, white, and transparent, yet strong enough to bear a surprising weight by square metre ranging from 900 to 1000 kilogrammes. This wonderful silk was brought to the balloon factory ready varnished with a waterproof composition, and was then entrusted to a few skilled men to be systematically cut *en forme* in forty zones or circular sections, each divided in turns in sixteen trapezium panels, and strictly of the same size. The thirty-two panels of two corresponding zones on either side of the small axe were therefore cut at once, with due allowance for the seam turnings. The two small pieces for the peaks, requiring more strength, had to be doubled. The next process was the stitching by sewing-machine, executed by expert women who had to regulate to a nicety the tension of the stitches, a most important item to secure the proper stretching of the silk bag. The zones and various pieces joined into series then passed through the hands of different workmen, who, with brush and varnish, went carefully over the seams to close the minute prickings of the sewing-machine. Each



SANTOS-DUMONT'S AIRSHIP ON THE GROUND.

round had then to be slipped on a kind of wicker-work *mannequin* and raised out of the way, like a chandelier to the ceiling, to let dry. Once more the detached sections of the silk were taken back to the machinists to be sewn definitely into a complete bag or shuttle case. Again the newly made seams had to be varnished over and dried. The entire length of the seams is put down as 1,500 metres, whilst the cost of the envelope is estimated approximately at £300." This was the balloon for "Santos-Dumont VI."

It was in 1899 that M. Deutsch, a well-known petroleum refiner and member of the Aëro Club, made his offer of £4,000 to the aeronaut who succeeded in directing an airship from the grounds of the club round the Eiffel Tower and back to the starting-point in half an hour. Señor Santos-Dumont had already succeeded in circumnavigating the Eiffel Tower, though this fact does not seem to have attracted wide notice. But the conditions of this prize were severe, both in respect to time and place, and when, in the summer of 1901, it became known that the young Brazilian meant to enter for it, all Paris was agog with excitement.

Several preliminary trips were made, and on Saturday, July 15th, 1901, the intrepid explorer of the atmospheric ocean set out from St. Cloud on board the "Santos-Dumont V." to try for the prize. He failed, but failed splendidly. Leaving the Parc d'Aërostation at St. Cloud at 6.41 in the morning, he reached the tower in thirteen minutes, rounding it at the level of the second platform, within a distance

of thirty yards, and coming back against a head wind, reached the Aëro Club's grounds at 7.22, thus making a trip of more than seven miles at an average speed of thirteen and three-quarter miles an hour. But an accident occurred before the aeronaut could land in the grounds.

"This performance is above either praise or criticism!" exclaimed an eye-witness. "It is a new fact in our lives."

The epoch-making trip, failure though it was, has been splendidly described by the Paris correspondent of the *Daily News*, who points out in the first place that the weather was distinctly unfavourable to the enterprise. The correspondent writes as follows :

"About 5.20 a.m. the gates of the huge shed were thrown wide open. The balloon, inflated about 3 a.m., was released from its sand-bag moorings and brought out into the open, where it was easily made fast, the Santos-Dumont balloon being just poised and depending upon its machinery to raise or sink it. It looked like a gigantic double-pointed cigar. Its length is 110 feet, and its capacity is exactly 550 cubic metres or about 15,000 cubic feet, which means that, being inflated with hydrogen, its ascensional force is about ten hundredweight. As the balloon is exactly poised, that figure may be taken as the weight of the balloon including the car, its occupant, a small quantity of ballast, and the engine. This engine, built by M. Beche, belongs to the famous Daimler type of oil-motors. It is the lightest one of its power in the world, developing fifteen horse-

power, and weighing a few ounces under 180 pounds, being but eleven pounds for every horse-power. I should be afraid to ask the price of such a motor *de luxe*, which is more like a piece of goldsmith's workmanship. It has four cylinders. The shaft is hollow, and it works a single screw with two blades of thirteen feet span, and revolving two hundred times a minute. The rudder, placed a little behind and above the screw, is a piece of silk stretched on a triangular frame. The car, the engine shaft, and screw, are all mounted in tandem on a light bamboo frame running beneath the balloon, and fixed to it by means of steel wires that look like gossamer. The framework is held together by aluminium joints.

"Every detail of the machine has been thought out, contrived, and tested with the utmost care. M. Deutsch was one of the most enthusiastic in wishing godspeed to M. Santos-Dumont, whose every trip in his airship is, of course, taken at the risk of his life. M. René de Knyff, one of the three or four competitors in the Paris-Berlin motor-car race, listened to the loud rattle of the motor, and shook his head from time to time. A sound like that of a pistol shot showed that everything was not all right. It turned out that one of the four cylinders was out of order. On the return journey—if I may anticipate—another cylinder got out of order through overheating, and this spoilt everything.

"M. Santos-Dumont, who, it need hardly be said, is a thorough sportsman, declared that he would start and try his luck. Just then the wind was blowing seven yards a second. M. Santos-Dumont had

taken his place in the tiny wicker-basket just large enough for the short and slender man he is,—and I suspect he has been reducing weight these last few weeks,—he had thrown off his coat, and was in his shirt-sleeves, wearing a light Panama hat. It was 6.30; the morning was gloriously beautiful. At the foot of St. Cloud heights was the silver streak of the Seine, beyond which the trees of the Bois de Boulogne appeared like a green sea overhung with a slight mist. Beyond, phantom-like, rose the Eiffel Tower, the colossal mile-post of this trial. M. Deutsch once more shook hands with M. Santos-Dumont, and warmly, indeed, affectionately, wished him speedy return. M. Jeantaud began to count off the seconds by the chronometer. A dead silence prevailed among the crowd. ‘Let go!’ ‘Good luck!’ cried back hundreds of voices. The engine rattled like mad. Slowly the flying-machine soared aloft; the guide-rope caught here and there, seeing which, and the danger it portended, M. Santos-Dumont threw out a few handfuls of sand until it had cleared the trees.

“The balloon turned first to the north, as if to sniff the breeze. Then, about sixty feet from the ground, it bore round, the nose pointing upwards as if climbing a gradient. It described a beautiful sweep in the air until it pointed towards the Eiffel Tower, when it shot off in a straight line at the rate of twenty miles an hour. Everybody’s heart was with the plucky little Brazilian. A tremendous cheer went up, echoed by several thousand persons outside. The beautiful manœuvre at the start was

so novel, startling, and significant that everybody was thrilled. 'Vive Santos!' cheered the crowd as if with one voice. Then there was a rush to some rising ground in the neighbourhood. The airship was sinking, and was carried by the wind a little out of its course. But it soon got back again and, some trees being in the way, nothing more could be seen of it. Some with glasses thought they saw it creeping behind the Eiffel Tower, but they could not be sure because of the mist. A few seconds later it appeared on the other side hugging the Tower. 'Bravo!' 'Well done!' The little speck was growing larger and blacker, and the polished brass cylinder flashed towards St. Cloud like a heliograph announcing good news. It was now only a few hundred yards distant. The cheers were deafening—cheers of enthusiasm. But the wind freshened, the balloon made headway, then, weakened, its propeller was slackening; it came in a plumb line above the Parc d'Aérestation, then the propeller stopped. What did it mean? The timer announced that it was ten minutes late. Cheers broke out again—cheers of encouragement. Well done, all the same. Then the propeller was seen to stop, and the balloon was carried away towards the Bois de Boulogne, where it was seen to sink among the trees in Baron Edmund de Rothschild's park."

Señor Santos-Dumont explained the accident to the *Daily News* correspondent in these words:

"The motor did not work as it ought, and the side wind delayed me. I reached the Eiffel Tower in thirteen minutes, and went round it with the utmost

case. But the return was more difficult ; and above Auteuil a second cylinder broke down. I had to throw out ballast, and this disturbed the equilibrium of the airship, so that I was unable to come down at the right moment. As I was afraid of being carried away to Paris, where I should have come to grief, I determined to land in Baron de Rothschild's park. The balloon spun round and was caught in some trees. I hung on to a branch while the gardeners were bringing ladders. I was able to bring down my balloon—which I was delighted to find had suffered no damage. Baron Edmund de Rothschild came up to me, and said that if it were necessary, in order to save the balloon, he would at once order the trees to be cut down."

So ended the first of his series of plucky and eventually successful attempts to carry off the Deutsch prize. But he had already established the great fact that it was not altogether impossible, even against variable winds, to steer an airship to a given point and return to the place of starting. He had also proved that the question of his winning this prize, which was meant to mark an epoch in the science of aerial navigation, was only one of a few more improvements in his machinery.

This trip made him the lion of the hour in Paris, and attracted universal attention. Indeed, the curious jealousy of the French for all foreigners who endeavour to win honour in their country soon asserted itself, and when it became apparent that a Brazilian was likely to carry off the Deutsch prize and not—as they had hoped—a Frenchman, Santos-Dumont

became the object of an extraordinary outburst of jealousy on the part of Parisian "sportsmen," though he remained a popular hero with the people, and calmly went about his preparations for a further attempt.

His next ascent with the same airship took place on the afternoon of Monday, July 29th, at half-past three, when he was favoured with splendid weather. After three false starts, due to the loosening of part of the machinery, the young aeronaut made an excellent ascent, and having risen 200 yards, he put his motor and propeller into action, and the balloon proceeded in a straight line towards the south-east. Sailing right round the Longchamps Hippodrome, he followed the line of the big track, then came back to his starting-point without accidents, the whole expedition having lasted fifteen and a half minutes.

Señor Santos-Dumont stated that he was quite satisfied with his experiment and that he had made a good deal of progress since his previous attempt. The reason why he did not renew his attempt to gain the prize for rounding the Eiffel Tower, was that his motor became too heated, and his airship pitched too much, and also that he himself had hurt his hand, so that the experiment would not have been carried out in very favourable circumstances.

Perhaps the most momentous day in the life of Santos-Dumont was Thursday, August 8th, when he again endeavoured to fulfil the conditions laid down by M. Deutsch. The most vivid account of that memorable morning was that penned by the

Paris correspondent of the *Daily Express*, to whom we are indebted for the particulars which follow. This correspondent, it should be noted, had gone to the Eiffel Tower on a big Mors racing-motor, having arranged with the aeronaut to race back to St. Cloud :

"At six o'clock we saw the balloon climb high into the heavens and turn its yellow prow toward the tower. Santos-Dumont came rushing in flight as straight as a rifle barrel, and seeming as fast as a rifle bullet. His ship was sailing with the wind, and sailing faster than ever moved a Yankee cup defender. The rattle of the motor, heard a mile and a half away, brought people to the roofs. The workmen gazed aloft. It was an exhilarating spectacle, thrilling, enchanting. At 6.5 Santos-Dumont was at the tower. He rounded the great iron stake boat with ease, gracefully slowing down, so as to convince all of his performance ; and as the ship swung around there was a mighty cheering from near and far. Santos-Dumont waved his hat in pleased response.

"So far all was well. But now a very *Iliad* of troubles began. The wind beat the airship back, the motor worked badly, and the gas began escaping, for a piano wire had ripped open an eyelet. Santos-Dumont soared upwards to twice the height of the Eiffel Tower, and then, 2,000 feet in air, climbed from his basket and clambered along the dipping, swaying, gossamer-like keel to overhaul his motor. It was sublime daring.

"Men below him turned away their eyes. Santos-Dumont stood well outside his basket on two slender sticks, not so large as broom handles and three feet

apart. He held on by the third slim strand of wood that formed the apex of the triangular keel. The glass showed every movement. He worked furiously for a few seconds, and then went back to his car. All this time he was beating slowly back towards St. Cloud.

"It was easy to beat Santos-Dumont back at that rate. The Mors crossed the bridge, and flew up the Quai de Passy for about half a mile. We stopped near the river, for Santos-Dumont was making small headway. His ship plunged like a lightly laden vessel in a great storm. It was fully one quarter deflated, and the motor was working feebly. When the bow rose up the gas swelled it full, and the stern crinkled and doubled over empty. As the bow dipped this action was reversed, the stern filled and was buoyant, while the other end sagged like a wet towel.

"Bravely Santos-Dumont kept the prow to the wind ; magnificently he struggled to gain St. Cloud. Once the ship turned as if to run before the wind, and did go a few yards, when Santos-Dumont swung her back to her course. A short gain followed, then came a standstill, and the ship fluttered in the air and flopped alarmingly. Santos-Dumont was being tossed on great wind swells in a wrecked airship !

"The stern sagged, and the propeller, still slowly revolving, caught in the supporting piano wires. There was a ripping and a rush of gas. With a sickening, despairing flop the airship began falling. It was half a mile distant from the right bank of the Seine. One could hear screams from every housetop. But Santos-Dumont, as seen through

the glasses, was in no degree alarmed. Though falling at high-speed he kept his head, and slipped the heavy guide-rope down by the propeller in order to lower that end. As he was in the bow it was better for him to have the stern hit the ground first. He fastened his belt to a hook in the basket. This took seconds only.

"In the first thousand feet the wind was blowing the ship so that it slid down a long incline whose end appeared to be the Seine. The last thousand feet were covered with a rush like that of a lift falling down its well. At the last moment, when almost on the roof of a great hotel, the last between him and the river, which flowed 100 feet away across the Quai, Santos-Dumont flung out ballast. Falling at that velocity it was amazing how he did it, but, when only a few feet above the roof, he threw out sand in showers.

"It seemed for a slight fraction of a second that he had thus escaped the roof, and would be precipitated in the Seine, where a boat had already been manned to pick him up. The keel carrying Santos-Dumont and the motor had skimmed over the edge of the high roof, but the silk lagging behind caught at the extreme end on a chimney-pot just as the last part was going over. The balloon itself tore right in two, but the wires running from the prow to the keel caught also, and they held. With a mighty jerk Santos-Dumont stopped his flight in mid-air, suspended forty feet from the ground against a blank wall eighty feet high. His keel hung by the wires stern downward with half the balloon draped about it. The other half

hung to the chimney-pot. Santos-Dumont lay horizontally on his back in the car, his head and shoulders clear outside.

"Then a new danger arose. The wires began to tear loose and the keel to drop. Santos-Dumont was cool still. By swaying his body he swung the lower end of the keel upon a ledge, where it rested. Still the danger was not over. The keel standing on end was forty feet high, and Santos-Dumont was at the top. His weight made the light affair topple perilously toward the great court. Again he was Ulyssean in his craft. Hanging on by his belt to the basket, he pulled the yielding wires until the keel balanced on end. Then he gave a quick jerk, and it fell into a corner, and the great danger was over."

The above is a graphic account of a scene which is surely unique in the annals of the air, and the coolness which Señor Santos-Dumont exhibited in these most perilous circumstances could not be surpassed. While still in his uncomfortable position, he called to his friend, the clever journalist whose sketch we have quoted from, to drop him a cigarette, the correspondent, along with the firemen who had come to rescue the aeronaut, being on the roof of the hotel. Santos-Dumont was eventually released from his uncomfortable position by the firemen hauling him up the wall by means of a rope. "He was laughing like a boy, unworried and enthusiastic." That is the stuff successful aeronauts are made of! It was probably this dramatic coolness in the face of great danger that appealed to the *Figaro*, which instantly suggested that the Cross of the Legion of Honour

should be conferred on him. The damage done to the airship was estimated at £2,000.

The disaster naturally produced a crop of criticisms, most of which went to show the futility of trying to drive a balloon through the air. Mr. George Griffiths, well-known as an author and traveller, said :

“The lesson of this disaster, if M. Santos-Dumont will so far modify his splendid courage as to be able to understand it, is simply this—The navigable balloon is navigable only in a calm or in light winds, and it often happens that a balloon may rise in a calm from the earth, and at, say, 1,000 feet, meet a wind blowing thirty miles an hour. I once did this, and met one blowing sixty. In such a case he certainly would not have escaped with his life in fact, he would have been blown over the sharp edge of eternity, and would have found his end anywhere on the continent of Europe or the Mediterranean, according to the direction of the wind.”

Mr. Griffiths, of course, is one of those who refuse to believe in the possibility of any airship ever being made which will be capable of driving against headwinds, so long as the principle of the balloon is retained in any degree. He contends that what happened to Santos-Dumont was that the balloon caved in when forced by the machinery against a contrary wind ; the hydrogen gas became compressed—it is capable under pressure of being solidified—and as it was forced by air pressure to the end of the balloon it tended to upset the equilibrium, and that once lost, all is lost but luck. Fortunately Santos-Dumont preserved his luck. As a matter of fact,

the aeronaut himself denies that his balloon has ever been vitally affected by being forced against the wind.

The author from whom we have just quoted recounts an incident which happened to himself when crossing the channel in a balloon. "At a height of 7,000 feet a dense cloud came between us and the sun," he says. "The gas in the envelope shrank, and in five minutes we fell 2,500 feet. Now, if we had only been 1,000 feet above the channel when that happened we should have been smashed up on the surface of the channel, because when you hit water like that it is practically as hard as one of London's streets. This is another of the impossibilities which block the way of the navigable balloonist. The slightest fall in temperature diminishes the volume of the gas instantly, and unless you get the ballast out pretty quickly, down you come. If you have not the ballast nothing can save you, and no so-called navigable balloon can carry sufficient ballast, plus the motor, to save from a fate like this, granted the circumstances which I have just described."

He argues from this that had Santos-Dumont fallen 1,000 feet he would have been done for; and the conclusion seems reasonable.

CHAPTER VI.

Santos-Dumont's Achievements—Failure and Success—"King of the Air"—Ambitious Projects.

NO warnings, of course, could cool the ardour of the intrepid young Brazilian, and almost as soon as the circumstances of his shipwreck in mid-air became known, the fact that he had ordered a new flying-machine was reported. The balloon of "Santos-Dumont VI." was to weigh 242 pounds, instead of 264 pounds, and be tougher withal. It was to be ready by September. His workpeople kept their word; and it is indeed surprising how fortunate Santos-Dumont has been in this respect. In the days of the early pioneers the difficulties encountered in their dealings with workpeople concerned in the construction of their balloons were soul-saddening and fatal to all but the truly patient or burningly enthusiastic. Our modern "King of the Air" has been happily spared these worries, his assistants vieing with each other in helping forward the success of his experiments.

On Friday morning, September 6th, Señor Santos-Dumont made a trial trip with his new airship, the occasion being again marked by a mishap. In the presence of a large assemblage of enthusiasts

he mounted to a height of 160 feet, and moving with great rapidity, crossed the Seine. The spectators were absolutely amazed by the speed attained, and by the perfect control over the aerostat which Santos-Dumont manifested. While they were still wondering, the balloon was suddenly seen to stop, the drag-rope being hauled taut. It was soon found that the rope was knotted about a tree in the park of the Chateau de Boulogne, belonging to Baron Rothschild.

This necessitated a rapid descent. Without alighting, Santos-Dumont discovered that the wooden frame was strained, requiring an immediate return to the shed. Still remaining in the basket, the aeronaut superintended the towing of the balloon back to the Aëro Club grounds. On the way the rope caught in the telegraph wires, and the balloon collided with a house. This necessitated its deflation, and on descending the framework was broken.

This new mishap involved more delay and further improvements. Meanwhile a discussion arose as to the conditions of the Deutsch prize. The Aëro Club somewhat suddenly decided that airships competing for it would be considered to have started as soon as their guide-rope had been released, and to have arrived as soon as it had been caught again. Against this new condition the Brazilian aeronaut publicly protested, arguing that on a racecourse the time is taken when the jockey passes the post, and not when, having stopped his mount, he hands his reins to the boys. Similarly the balloon ought to be reckoned as having arrived as soon as it is above the ground. In all such trials the winning-point is the crossing of

an imaginary line. On the other hand, Commandant Renard, Director of the French War Office Balloon Establishment, and who is celebrated for having, in 1884, built a balloon which it is said was capable of being steered, maintained that the conditions of the Deutsch prize were much too easy. If he had not been a government servant and debarred from entering private competitions, he could have won the prize (so he said) with his "France," as she was in 1884. He criticised Santos-Dumont's airship as very imperfect. "It is lacking in all the secondary qualities necessary. It is not stable, and cannot be steered scientifically. But, for all that, M. Santos-Dumont's pluck and ability are to be admired." M. Roze's airship also he considered too complicated, and thought that the future was with the "heavier-than-air" machine.

The Brazilian aeronaut was soon making fresh ascents and trial trips. On the afternoon of Wednesday, September 18th, he made several captive ascents, and remained nearly an hour in the air, performing evolutions in all directions. It was then stated that his new rudder, double the size of the old one, had much more grip on the air, and enabled the airship to be easily steered in a circle. There were certain failures in the motor during the ascents, but they were not of a serious character, and some slight repairs were expected to put everything into perfect working order.

His next attempt for the prize took place on the morning of Friday, October 11th, and resulted, once more, in failure. Yet was everything in his favour,

the weather being ideal and the machinery apparently in perfect working order. Amid cheers the aerostat mounted skyward, but the drag-rope had scarcely cleared the ground when it was seen that the rudder refused to work, and a moment later the undaunted Brazilian brought his ship to earth.

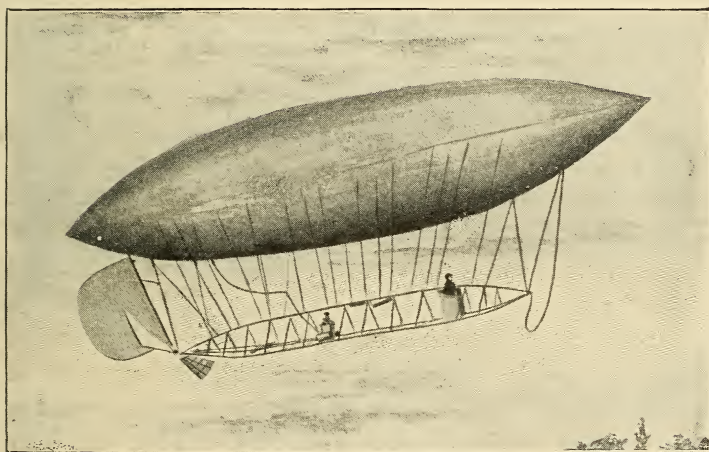
"What's wrong?" cried a multitude of voices. But Señor Santos-Dumont himself did not know. Soon afterwards he discovered that one of the bamboo rods supporting the guide wires had broken. The airship was taken into the shed, and an hour later emerged with the rod replaced, and shot up into the air pointing to the Eiffel Tower.

It travelled at tremendous speed, says an eyewitness, and every one shouted, "He'll do it!" Over the Bois de Boulogne the ship was seen to point obliquely upwards, change direction, and descend rapidly. It was clear that something again was wrong. The airship landed on the Longchamps racecourse, where investigation revealed tangled guide-ropes and other obstacles to progress; so, saving some short experimental spins, the remainder of the afternoon was spent in making repairs.

Further trials took place, and on Monday, October 14th, Santos-Dumont made his twenty-fifth ascent, flying, for the first time, the French flag. He spent the greater part of the hour and forty minutes in flying hither and thither, over and around the course at Longchamps, keeping all the time within the railing until he returned to St. Cloud, and never rising high in the air, as the upper currents were unfavourable.

The Paris correspondent of the *Times*, who from the first took great interest in the work of the Brazilian aeronaut, writing of this day's manœuvres, says :

"It was evident beyond all dispute that an enormous step had been taken towards the conquest of the air. The balloon, like a bird trained to obey the human voice, executed all these movements with



THE "SANTOS-DUMONT VII."

wonderful precision, turning round, advancing rapidly, returning rapidly—in short, acting like an intelligent being having the mastery of its own movements."

Five days later—Saturday, October 19th—will ever be remembered as a red-letter day in the annals of aerial navigation. At noon the weather was cloudy, though calm, and inclined towards rain. But two hours later the aeronaut was ready for his great enterprise, and set off on one more brave effort to

round the Eiffel Tower. After a false start, in which he cleverly avoided an accident, he set out at 2.42 p.m., the Marquis de Dion acting as timekeeper.

The memorable performance is admirably described in the words of the *Daily News* correspondent :

“Despite the wind on his starboard beam, M. Santos-Dumont headed straight for the tower, which was clearly visible. The machine flew across the Seine, keeping as straight as an arrow. It gradually rose, also keeping in line, however, with the goal. As it came abreast of the tower it seemed a little speck. The spectators in the park cheered. M. Santos-Dumont had performed the outward journey of three miles and a half in nine minutes. Just then the balloon was seen to swerve, as if buffeted by the wind against which it was struggling. However, the Eiffel Tower was safely rounded at the level of the third platform and at a distance of eighty yards.

“On the return journey the airship had the wind three-quarters against it. Suddenly it came to a standstill. The spectators at St. Cloud spent ten minutes of harrowing uncertainty. The propeller had got out of order. M. Santos-Dumont was but 5,000 yards from the tower, and the wind was blowing him against it at the rate of six yards a second. M. Santos-Dumont, a hero in his way, kept his head level. He has, indeed, never been known to lose his presence of mind in danger. He let go the rudder ropes, crawled along the slender framework, and set right the ‘carburetter’ and electric lever, which had stopped working. The motor was all right again. But not a minute too soon. The

airship had drifted somewhat out of its course, and had begun to fall. M. Santos-Dumont threw out a few handfuls of sand. A slight pitching movement was observable, and gave rise to some anxiety. Suddenly the sound of cheering came from the Auteuil race-course, a long way off. A horse-race had just been run, but the crowd were looking at the balloon over their heads. The rest of the home journey was smooth, and, in fact, the engine worked better than it had ever done. But for the two hitches above mentioned, the return journey would have been accomplished in a fraction over eight minutes, an even better record than the outward journey, although the wind was now blowing the wrong way. As it was, twenty-nine minutes and thirty seconds had elapsed between the start and the arrival over the grounds at St. Cloud. The airship, however, carried on by its own impetus, passed over the park. M. Santos-Dumont brought her sharply round, a very fine manœuvre. His guide-rope trailed on the ground, being caught by one of his workmen.

“The Brazilian aeronaut’s sympathisers were wild with enthusiasm, and called out ‘Victory! Victory!’ M. Santos-Dumont’s features lighted up. He looked round the circle of friends, and inquired, ‘Have I really won? Tell me! Tell me!’ M. Deutsch came up, and hugged M. Santos-Dumont, remarking, ‘My own view is that you have won the prize, but you are a few seconds over the time.’ M. Santos-Dumont was pale and speechless. The Marquis de Dion coming up, watch in hand, addressed him, ‘My friend, you have missed the prize by forty seconds.’ This

aroused cries of dissent from the crowd. The Marquis de Dion replied, 'We have to go by the regulations.' M. Santos-Dumont remarked, 'I know I have won the prize, and if I do not get it I will not try for it again. Not I, but the poor of Paris, will be the losers.' 'Since you talk of the poor,' said M. Deutsch, 'I offer you £1,000 for them,' but M. Santos-Dumont rejected this offer with scorn."

To cut a long story short, the young Brazilian had really won the prize. He had at last succeeded in fulfilling all the essential conditions, despite the fact that it was not until November 4th, when the whole subject had been thoroughly thrashed out in heated discussion, that the committee of the Aéro Club, by a majority of thirteen to nine, awarded him the coveted prize, a decision of which M. Deutsch cordially approved. So the poor of Paris benefited to the extent of £2,000, and a similar sum was divided among Señor Santos-Dumont's faithful workmen.

Had his achievement solved the question of steering a balloon? That point will be discussed in its proper place, the purpose of the present chapter being merely to record facts.

Meanwhile we cannot pass from the story of this never-to-be-forgotten day without recording the aeronaut's impressions of his famous trip. He confessed that same evening that he had not been afraid at any time, but was awed, and for just a single instant he felt doubtful of final success. But he cast aside all doubt when, in a flash of thought, the whole of his balloon arrangements presented themselves to his mind. Then he not only hoped, but felt confident.

Hailed "King of the Air," awarded a gift of £11,000 by the Brazilian Government, naturally proud of the lustre which he had shed on his country's name, Señor Santos-Dumont, at the end of 1901, was assuredly the man of the moment. In November he visited London and was cordially received. He was full of projects, infinitely more daring than his trip round the Eiffel Tower. Nothing short of a genuine tour "Round the World in a Balloon" will satisfy his ambition.

His first attempt this year was to have been a flight from Monaco across the Mediterranean to Algiers. His early experiments at the beginning of the year were favourable enough; but in February he suffered a second shipwreck in the air and fell plump into the Bay of Monaco! Again his luck stood him in good stead, and he emerged from the disaster like Claudian from the earthquake!

It remains to be seen, however, whether he can out-do his feat of rounding the Eiffel Tower with an aerial machine that is admittedly very imperfect in principle and detail, and of a type which is never likely to prove of any real service in the navigation of the sky. For, after all is said, it is very obvious that in unfavourable atmospheric conditions airships such as those with which Santos-Dumont has experimented cannot be relied upon. Yet it will not be denied that this ingenious Brazilian has rendered an immense service to aeronautics by awakening universal interest in the problem of steering a machine through the air.

CHAPTER VII.

Scientific Ballooning—The Colour of the Sky—Effects of Height—Air-currents, etc.

IT is sometimes asked, "What good would it be to the world if the North Pole were found?" It is a natural question, for the average man is no scientist and he fails to understand the great principles of the earth's laws which would be settled by the discovery of the Pole. Similarly, the fact that when Montgolfier floated his first balloon he had placed a magnificent instrument in the hands of science was not realised for some time, and has not yet been made the most of. Still, few people are aware how largely science has benefited by the balloon, though many large works have been written about scientific discoveries resulting from ascents into the higher regions of the air. In this chapter we propose to glance briefly at some of these additions to knowledge, and to show how much the science of meteorology has profited by the aerial explorations of such men as Gay-Lussac, James Glaisher, Camille Flammarion, and others.

A hundred and fifty years ago comparatively little was known about the fascinating cloudland from which the roll of thunder and the lightning flash

occasionally come to remind us of the wonders that God has worked up there. To-day, while there is still much to learn, many of the phenomena of the upper atmosphere are as fully understood as those of the atmosphere we breathe every moment of our lives.

Gay-Lussac, the celebrated French chemist, was one of the first and the most noteworthy of the early scientific explorers of the atmospheric ocean. A whole chapter might be devoted to his observations, but we must be content with a very brief summary, based on the particulars given by Monck Mason in his valuable *Aeronautica*. In company with M. Biot, another French philosopher of like celebrity, he ascended from the Conservatoire des Arts, in Paris, August 23rd, 1804, with a view to instituting experiments in various branches of the physical sciences. At an elevation of about 11,000 feet they let go one of the birds with which they had been provided; for a moment it rested upon the edge of the car; then, launching into the deep abyss, directed its course in gradually extended circles towards the earth; thereby refuting an erroneous opinion generally prevalent that the rarity of the atmosphere in such elevated situations was incompatible with the exercise of their natural functions.

Upon letting down a wire of about 200 feet in length the explorers obtained, by means of the electrophorus indications of negative electricity from its upper extremity, a result which appears strongly to confirm the opinion given by Volta and Saussure regarding the increase of the electric matter in the

superior regions of the sky. Having obtained an elevation of about 13,000 feet without being able to discover anything further worthy of especial record, they descended.

The results of this experiment not having realised the expectations of the scientific in Paris, owing chiefly to the limitation which the weight they carried imposed upon their ascent, it was resolved to make another attempt, in which Gay-Lussac should go up alone. Accordingly, on September 15th, in the same year, that gentleman again ascended from the same place, and the results of this experiment are much more important to science than those just recorded. At an elevation of 9,929 feet the oscillations of the horizontal needle appear to have been considerably accelerated; giving a result of twenty in eighty-three, although on earth the same number would have required 84.33. The variation, as far as his means would enable him to determine, appeared at the height of 12,651 feet to be exactly the same as below.

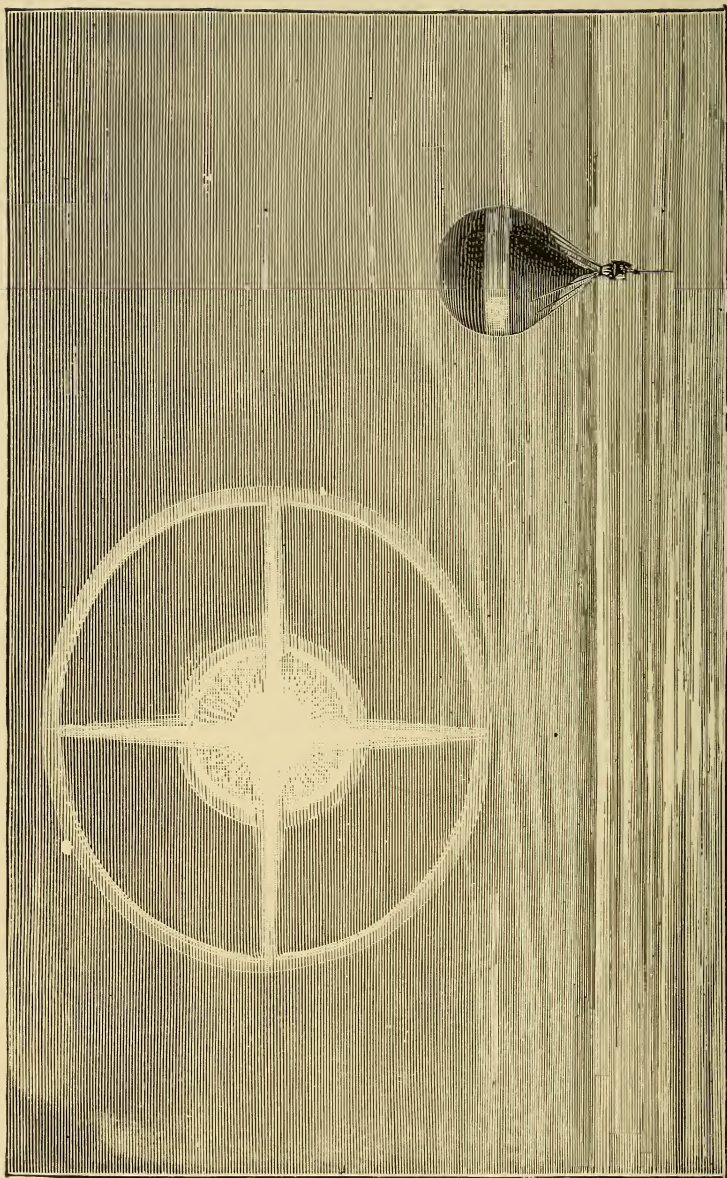
At the height of about 5,000 feet, we are told that two large glass balloons, which had been previously exhausted of air, were opened for the purpose of subjecting to analysis a portion of the atmosphere abstracted from such an elevation. The result of this inquiry proved no difference whatever in the composition of the atmosphere at that elevation.

Having reached a height of 22,977 feet above the level of the sea, and almost all his ballast having been already disposed of, he considered it prudent to arrest his further progress. The appearance of

the sky at this, the extreme point of his ascent, was particularly interesting; the colour, especially about the zenith, being comparable only to a fine shade of Prussian blue, while, notwithstanding his excessive elevation, he could still perceive the clouds in considerable abundance floating at an apparently measurable distance above his head. The temperature had fallen as low as 17° Fahrenheit. Although well clothed, he now began to suffer from the effects of the cold, especially in his hands, which he was obliged to keep exposed and constantly employed in handling the various instruments necessary in making observations. His respiration, likewise, he describes as being sensibly affected, and, as well as his pulse, considerably accelerated; not so much, however, as to occasion him any great inconvenience, or to render it necessary for him to precipitate his descent.

These were the earliest scientific observations made at this height, and since then many of Gay-Lussac's conclusions have been modified, due mainly to the great advance that has been made in the construction of scientific instruments.

For nearly half a century the scientific study of the upper atmosphere was practically neglected, and the next ascents of any great importance were undertaken by Barval and Bixio in 1850, when they reached the same height as Gay-Lussac—about 23,000 feet. Then came the most famous of all the scientific ascents—those accomplished by James Glaisher in 1862–66, which are especially interesting to Englishmen, since he was a countryman of ours.



A STRANGE SCENE IN CLOUDLAND: CURIOUS HALO ROUND THE SUN, OBSERVED FROM THE BALLOON "ZENITH."

Doubt has been cast recently on some of Glaisher's observations, and the capacity of his instruments has been questioned. He himself has recorded that "the first aneroid barometer which I had made for these observations read correctly at thirty inches, and 0·1 inch too high at twenty-five inches ; the error increased to 0·7 inch at fourteen inches, but decreased to 0·5 inch at eleven inches. A second aneroid barometer read very nearly the same as the mercurial barometer from thirty inches to twelve inches range. A third, graduated down to five inches, and most carefully made and tested under the air pump before use, read the same as the mercurial barometer throughout the high ascent up to seven miles on September 5th, 1862. I have taken this instrument up with me on every subsequent ascent, and it has always read the same as the mercurial barometer. These experiments prove that an aneroid can be made to read correctly at low pressure." From this it will be seen that to question the results he arrived at is quite unjustifiable ; but, indeed, all scientists of authority are willing to concede that Glaisher's observations are thoroughly trustworthy.

There will always be different experiences in respect to purely physical effects on the individual, and, as we have already seen, one man may feel no difficulty of breathing where another is gasping for breath ; in fact, one man may die in conditions from which another emerges with his life. "At six and seven miles high, I experienced the limit of our power of breathing in the attenuated atmosphere," says Glaisher ; and he points out the great difference

between climbing a mountain and soaring aloft in a balloon. The energy expended in the one case brings an earlier consciousness of the rarefied air than in the other, where no energy is expended in making the ascent.

In the chapter on "Famous Aerial Voyages" we have already learned the effect of height which Glaisher experienced when upwards of 29,000 feet above the earth. To this may be added now the following interesting observations made by Glaisher and recorded by him in his volume, *Travels in the Air*:

"In this ascent six pigeons were taken up. One was thrown out at the height of three miles, when it extended its wings, and dropped like a piece of paper; the second, at four miles, flew vigorously round and round, apparently taking a dip each time; a third was thrown out between four and five miles, and it fell downwards as a stone. A fourth was thrown out at four miles on descending; it flew in a circle, and shortly alighted on the top of the balloon. The two remaining pigeons were brought down to the ground. One was found to be dead; and the other, a carrier, was still living, and would not leave the hand when I attempted to throw it off, till, after a quarter of an hour, it began to peck at a piece of ribbon with which its neck was encircled; it was then jerked off the finger, and shortly afterwards flew with some vigour towards Wolverhampton. One of the pigeons returned to Wolverhampton on Sunday, the 7th, and was the only one I ever heard of.

"In this ascent, on passing out of the clouds there

was an increase of nine degrees, and then there was no interruption in the decrease of temperature till the height of 15,000 feet was reached, when a warm current of air was entered, which continued to 24,000 feet, after which the regular decrease of temperature continued to the highest point reached. On descending, the same current was again met with, between 22,000 and 23,000 feet. A similar interruption, but to a greater amount, was experienced till the balloon had descended to about the same height in which it was reached on ascending, and after this no further break occurred in the regular increase of temperature, the sky being clear till the descent was completed. From the general agreement of the results as observed by Regnault's hygrometer, and those of the dew-point as found by the dry and wet bulb thermometers, there can be no doubt that the temperature of the dew-point, at heights exceeding 30,000 feet, must have been as low as minus fifty degrees below the zero of Fahrenheit's scale, or eighty-two degrees below the freezing-point of water, implying that the air was very dry."

Glaisher notes many interesting points about clouds, agreeing with Nasmyth in thinking that flat-bottom clouds are resting on a stratum of air which is pressing them upwards, so that when we see such clouds in the sky we know that rain is unlikely. Mason noticed, and others have agreed with him, that when a balloon ascends into a rainy region it will be found, on soaring through the clouds from which the rain is falling, that another rainy region has been entered, a second series of clouds being in the act of condensing.

From which it would appear that when we have rain it is not merely from the clouds immediately above us condensing, but because a series of clouds still higher is also doing so.

Nearly every scientist who has practised ballooning has remarked that the earth as seen from aloft gives no clue to its convex shape, but really appears to be concave, as if the balloon were soaring above a vast hollow. It is also worthy of note that distance does not render objects on the earth obscure, but

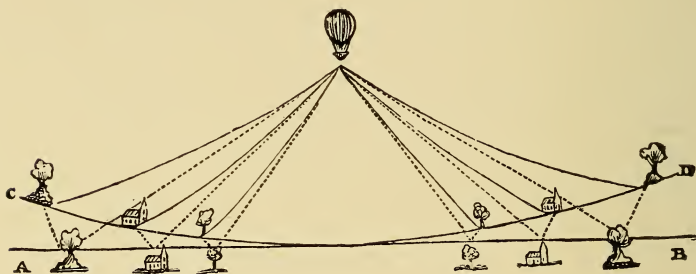


DIAGRAM SHOWING HOW **THE EARTH** IS SEEN FROM A BALLOON.

Owing to the power of refraction exercised by the atmosphere, the eyesight, instead of travelling direct to the objects as shown by the dotted lines, sees these raised higher, as shown by the plain lines, but still accurately as to distance. Hence the concave appearance of the earth from a balloon. Aeronauts have also experienced the delusion that it was only a step down to the earth when they have been hundreds of feet in the air.

intensifies their outline, until they become so minute that they finally disappear. Thus, when the pier at Calais seemed "no bigger than a match," observers from a balloon could still distinguish the people clustered on it. Bodies falling from a balloon have always been a favourite subject of experiment. At great heights a feather and a cannon ball fall with equal velocity, until they arrive in air which offers

a stronger resistance to the one than to the other. But the force with which the central gravity of the earth attracts them is the same in each case. Again, a falling body maintains the same horizontal inclination as that of the car from which it is dropped. Flammarion let a bottle fall from his balloon, and until it disappeared from sight it was seen "perpendicularly beneath the car," proving that Galileo's theory is right, for if the bottle had taken on an action of its own it would have followed an oblique line from the balloon, as the latter was moving at a considerable speed.

Here, again, is an interesting point: no air is felt in a balloon. Everything is deathly still, though the wind may be blowing a hurricane, for the balloon moves in the wind and is really a part of the blast.

Camille Flammarion has some important remarks on the colour of the sky as seen from a balloon. He writes:

"I shall teach nothing to my readers by informing them that the blue celestial vault has no real existence. The air reflects the blue rays of the solar spectrum from every side. The white light of the sun contains every colour, and the air allows all tints to pass through it except the blue, which it appears to choose specially, and to reflect in every direction. This causes us to suppose that the atmosphere is blue. But the air has no such colour, and the tint in question is merely owing to the reflection of light. If the air were blue in reality, distant mountains covered with snow would, as Saussure once remarked, certainly appear blue;

but this is not found to be the case. The air is colourless, but it is not absolutely transparent, since it retains and reflects the blue rays of the solar light.

“Planetary space is absolutely black. The higher we rise towards this external space, the thinner is the layer of atmosphere which separates it from us, and the darker the sky appears. At a height of 9,843 feet, we have passed through more than one-third of the atmosphere, as far as *weight* is concerned. It is, therefore, not surprising that the air above us should appear so dark, and that this shade should naturally decrease towards our horizon. The decrease of moisture adds its effect also in diminishing the intensity of the blue tint above.”

Much of interest might be written about the phenomena of clouds, but to deal with such subjects and especially in a “popular” way, requires more space than we can spare. So with many other aspects of scientific research in the upper atmosphere. But mention should be made of the curious shadow sometimes cast by a balloon, noted by Flammarion and other scientists. This takes the form of a silhouette of the balloon, shown on the cloud bed beneath, with a brilliant halo of rainbow colours all around it. The latter is supposed to be caused by the refraction of light from the tiny globules of water condensed on the covering of the balloon. Flammarion has also recorded that he saw the shadow of his balloon “luminous” on the earth, though few aeronauts have noted this; De Fonvielle indeed, asserting that light does not pass through a balloon.

Many explanations have been put forward as to why people experience no feeling of giddiness when soaring through the clouds. Almost any one could stand on the edge of the car and look down without the least sensation of vertigo. The most plausible theory of this is, that in the car of a balloon one looks up to the balloon and thinks of *that* rather than of the earth beneath. On the other hand, in a captive balloon there is more chance of giddiness when one looks at the cable by which it is held, and involuntarily regards *that* as the sole means of safety. But this peculiar fact has never been satisfactorily explained, and it will be noticed that even Flammarion in the following passage from the story of his first ascent makes no attempt to do so:

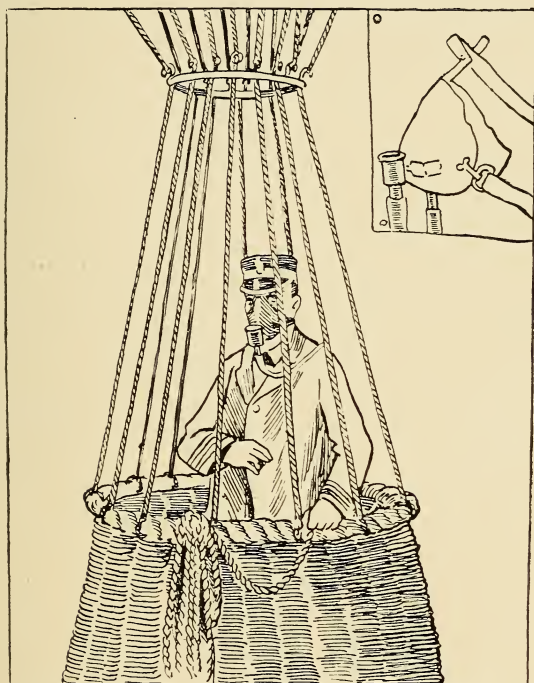
“The feelings of an aeronaut during a balloon ascent are almost impossible to describe. To the contentment of finding oneself floating high above the miseries of mankind is added the feeling of a strange and absolute calmness, such as is never experienced upon the earth. I myself never felt any giddiness, but my companion, Count Branicki, was affected by it from the moment we left the earth until we had passed over Villeneuve-St.-Georges. There appears, however, to be something imaginary about this; for the very time that the count should have experienced giddiness—that is, when he consented to look down upon the earth—the feeling left him. If the sides of the car had not rendered the thing quite impossible, our companion would certainly have allowed himself to be drawn down to the soil of France. I may add that, without having experienced

this disease of vision, I also felt a vague desire to throw myself out of the balloon. Though feeling convinced that it would be certain death, I was under the influence of a mild temptation to allow myself to fall, and my death became for the moment a matter of indifference to me. But, happily to those who travel in balloons, it is a species of temptation which there is no difficulty in resisting. These sensations are, I hope, confined to aerial navigation."

The Rev. J. M. Bacon has made many experiments, which must be mentioned in any sketch of scientific ballooning. His experiments in connection with acoustics have been particularly interesting, and were carried out by means of many ingenious instruments. As one writer has pointed out, Mr. Bacon's discoveries are likely to be extremely useful in the near future to sailors and to lighthouse-keepers, who constantly insist on the uncertainty of the audibility of the sound of a bell at sea. On one occasion, when making a balloon ascent from Newbury, Mr. Bacon caused the tenor bell of Hatcham Church, weighing upwards of a ton, and distant about three miles to windward, to be set ringing as in peal. The wind was a light breeze, and the balloon maintained altitudes varying between 1,000 and 3,000 feet, yet the bell was inaudible to each and all of the four observers in the car. On the other hand, it must be noted that Messrs. Mears, the well-known bell-founders, record the fact that the tenor bell of the peal of St. Bees, on the coast of Cumberland, has been heard at the top of Scafell Pikes, sixteen miles distant in a straight line. Mr. Bacon has also

achieved some excellent results in photographing from a balloon.

To discover the difficulties that confront man in the higher atmosphere is only to set inventive genius at



CAILETET'S APPARATUS FOR BREATHING AT GREAT ALTITUDES.

work, and quite recently a Frenchman, named Cailetet, has invented a device for supplying the aeronaut with the needful oxygen in a more convenient way than the old-fashioned plan of inhaling it through a tube. His contrivance may yet prove of great use to scientists who wish to penetrate even higher

than Glaisher went, and is thus described by its inventor :

“The apparatus which I have devised for the purpose of overcoming this difficulty consists of a double glass bottle, which contains liquid oxygen, and which is closed by a stopper, through which two tubes pass. One of the tubes ends above the surface of the oxygen, and it is provided upon the outside with a rubber weight, by means of which it is able to exercise atmospheric pressure on the liquefied gas. The second tube is of lead, and descends to the bottom of the oxygen, while its other end is connected with a vaporiser, or small and very light tubular boiler, which is fashioned of seven copper tubes communicating with each other.

“As copper is a great conductor of heat, the liquid oxygen, through the action of the weight, quickly becomes gaseous, and passes into a cylindrical rubber reservoir, which may be fixed in some part of the balloon. With this reservoir, containing about seventy litres of oxygen, is connected the flexible tube, through which the gas reaches the breathing apparatus. This apparatus is a sort of metallic mask, which is protected outside with velvet, so that it may not become chilled. It covers only the nose and mouth, and is fastened to the face by means of elastic bands. The oxygen which comes from the rubber cylinder penetrates into a mask through a flexible tube, which, when once placed into position, should not be stirred. In this way the absorption of the gas is assured, and the oxygen is obliged to penetrate into the lungs.”

The great quest of all scientists who have interested themselves in aeronautics is "the gulf stream of the air." The study of air currents is a most fascinating one, and touches a subject on which the best informed are still very ignorant. Some believe that in the upper atmosphere there exist currents as regular as the trade winds and the gulf stream, but no one has been able yet to define any of these, though their discovery would mean an enormous advance in ballooning. At one elevation a current may be blowing in a certain direction, but higher up the air may be travelling to the opposite point of the compass. This has been proved many times; and if it were possible to know at what elevation an aeronaut would find a current blowing in the direction he wished to be carried, then would the art of ballooning be immensely simplified and perfected. In a characteristic passage Gaston Tissandier writes :

"What should we know of the ocean if a few sailors only had navigated at a short distance from the coasts, without losing sight of port? Should we ever have had any notion of the vast currents that flow regularly from the poles to the equator, and reciprocally counter-balancing the heat of the one and the cold of the other? Should we ever have become acquainted with those vast fields of seaweed, those shoals of madrepores, or the regions of calm? Where would now have been the bases of the physical geography of the sea? The same argument applies to the gaseous ocean in the depths of which we live. Now that the telegraph has united all the nations of the earth, why do we not at once undertake simultaneous

balloon ascents at given periods of the year? Why should we not explore those higher regions systematically, and endeavour to discover the tides of the air?

“In our last ascent but one we rose into a heated current, the existence of which was not suspected by those on the earth’s surface. Where did this warm river, which flowed for a whole month over the clouds, arise? Where did it derive its heat? Did it come from the tropics? And why is the air so calm and stagnant to-day, like the tranquil water of an inland lake? What numbers of grand and useful problems arise when we think of the possible results of systematic balloon ascents!”

According to an American scientist, free balloons carrying self-registering meteorological instruments, but no observers, promise the greatest usefulness in the scientific exploration of the high air. The free balloons are now made of gold-beater’s skin, and weigh less than forty pounds. They are fitted with self-registering thermometers and barometers, which print the temperature, the humidity, and the atmospheric pressure at regular intervals, and with a machine that throws cards into the air every ten minutes, so that the course of the balloon can be traced by the cards that are picked up and posted to the central office. One of these free balloons, sent up by Hermite and Besançon, reached a height of ten miles, and others sent up by Dr. Assmann, of Berlin, have ascended to heights above eleven miles.

The same writer points out that the rate at which temperature diminishes with increasing altitude is a

very important datum to meteorologists. On the average it falls off one degree Fahrenheit for every increase of 313 feet in altitude. The allowance to be made for astronomical refraction depends directly upon this quantity. Changes in humidity, in the velocity of the upper winds, in atmospheric electricity, etc., are likewise registered in balloon ascents, and the physiological effect of high altitudes upon the observers is a matter of scientific importance. The air inside the body and outside of it are at different pressures, and above 20,000 feet "mountain sickness" is always felt.

We have already learned that at 26,000 feet Tissandier, in 1875, fell in a swoon, and when he awoke he found his two companions dead beside him. Dr. Berson, the German aeronaut, required frequent inhalations of pure oxygen above 20,000 feet to give relief, and at heights above 26,000 feet nothing but oxygen was breathed. The cold of the upper regions of the air is often intense. A rise of 31,000 feet corresponds to a fall of temperature approaching 100 degrees Fahrenheit.

Our American authority would, therefore, seem to be right in his conclusion, that to the free balloon meteorologists must trust for data concerning the highest air; balloons carrying observers will explore the middle regions, and the modern scientific kites will serve to carry self-registering instruments to heights approaching two miles.

CHAPTER VIII.

The Balloon in War—Its Use in the Past—Probable Development—For Signalling—Firing a Mine from a Balloon.

IT is generally stated that the military use of the balloon was first realised during the American Civil War ; but this is far from being correct. As a matter of fact, the balloon had no sooner been proved practical than military men began to consider how they could apply this new invention to their purposes ; and it is on record that the Battle of Fleurus, in 1794, was won by the French because of observations signalled from a captive balloon, which remained up all day. Military balloons were employed at Antwerp in 1815, and at Solferino in 1850.

It was at Solferino that the great value of the military balloon was placed beyond doubt. Says the *Times* correspondent in his account of the action which ultimately decided the issue of the war :

“The Emperor of the French, representing the juvenile irregular force, refused to be surprised ; he sent a man up in a balloon, and, at the expense of a few yards of silk and a few cubic feet of gas, is told the exact position of all those masses which are drawn up so scientifically out of his sight with the intention of surprising him at the comfortable, leisurely hour

of 9 a.m., Napoleon III. attacks at daybreak, chooses his own time, and remains master of the field."

During the siege of Paris by the Germans the French sent out more than sixty balloons carrying passengers, letters, and despatches. The carrier pigeons taken out returned bearing other despatches in reply. Captive balloons were employed by the French at Tonquin, by the United States in Cuba, and by the British in South Africa, with more or less success. But, as a scientific writer on the subject has observed, the ideal military balloon is the airship. It must be *dirigible*, easily manœuvred, safe, and capable of flying at any height and in any direction, even against strong winds.

It is interesting to note how Napoleon made use of Montgolfier's invention after the taking of Cairo in 1798, when he endeavoured to impress the vanquished Egyptians by sending up a fire-balloon after he had made a speech! The device was a failure, as only the French followed the flight of the balloon. Napoleon curiously failed to appreciate the true use of the balloon, for, as M. de Fonvielle has aptly pointed out, if he had had among the Imperial baggage when the day of Waterloo dawned such a balloon as had been used at Fleurus twenty years before, he would not have made the fatal error of "mistaking Blucher for Grouchy."

Very little progress, indeed, has been made in military ballooning, despite the fact that there are only three directions in which it is possible to experiment. First, by using captive balloons for making observations of the evening's position; secondly, for

signalling purposes ; and lastly, by using air-ships for communicating across a zone of country in the hands of an enemy, or for dropping explosives upon the latter.

Naturally, the French have always been the leaders in military ballooning, and the aerial escape of Gambetta from Paris during the siege is one of the most famous exploits of the kind. Commandant Renard, who is still at the head of the French war balloon service, was the hero of the siege. His balloon was cigar-shaped, with a screw propeller driven by a dynamo-electric machine, and steered with a large rudder, all the machinery being placed in a boat-shaped wicker-work car 150 feet in length.

Renard claimed a complete success for his invention ; he was able to follow the route he had previously mapped out, and by putting the helm about, turned his balloon in less than a thousand feet. The mean speed attained was twelve and a half miles an hour, so that the machine could only be manœuvred when the wind's velocity was not excessive. The latest French war balloon goes at double this speed ; while in 1889 M. Hermite travelled from St. Denis to the mouth of the Rhone in fifteen hours, a rate equal to that of an express train, notwithstanding the fact that he never escaped from the clouds during his journey.

Such progress as has been made since then has been achieved mainly by the French ; and now that both the Russian and French navies have realised the utility of the balloon for purposes of warfare, their armies are no longer the only branch of the service

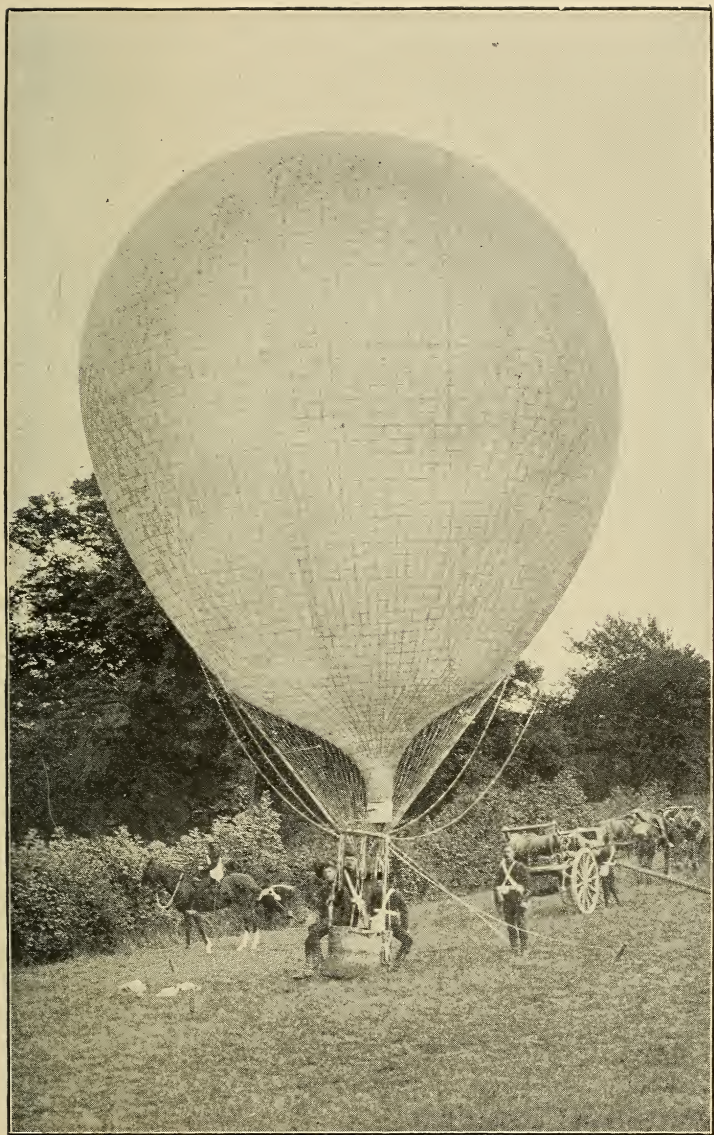
boasting an aeronautical section. The balloons are held captive in the ordinary manner, and are connected by telephone with the battleship below. A balloon section has been attached to the Mediterranean Squadron of the French navy for some time past, and has been employed with conspicuous success for scouting purposes. As we write, the Russians are carrying on experiments on the Caspian Sea, and if they consider that the balloon establishes its utility for naval scouting, a balloon is to be provided for each ship. Balloons for use with British warships have often been discussed, but, so far, no action has been taken.

The British Army, however, has long had a balloon service working in conjunction with the telegraph service. The method in which our military balloonists work is thus described: "The balloon is carried in a cart, attached to a huge reel of wire cable. When it is desired to ascend the balloon is filled with gas from tanks which are carried about with the section, and the cable is paid out until the officer finds he is high enough. To those who have written of the joys of ballooning the military balloon would come as an unpleasant surprise, for the tiny wicker-basket is less than three feet deep, and will hold no more than two men packed like sardines. Like all other captive balloons, it tugs and strains at its rope in a most alarming fashion, and the man who ascends for the first time in a wind will probably be fearfully sick, and will come down vowing never to repeat the experience. When it is remembered that in addition to the difficulty

of keeping his balance in the kicking leviathan, the aerial observer is expected to take observations of the enemy's movements, one can only gaze in admiration, and wonder how it is that the cheerful-looking officers of the balloon-section keep their hair from turning white."

The British balloon service is a branch of the Royal Engineers, comprising a dépôt and six balloon sections. The German Army has also a separate service; but Italy has no special balloon corps, though we have seen that it was during the Italian war, at the Battle of Solferino, when the immense service of the balloon was first placed beyond all cavil. To five of the Italian regiments of sappers, ten companies of train, and a railway brigade of six companies, which compose the corps of Engineers of the Italian Army, there is attached a "specialist company," which undertakes multifarious duties, of which ballooning is one. This special company, besides the charge of balloons, looks after "optical telegraphy," *i.e.*, long-distance signalling by heliograph, electric, and other lights, and the traction engines and carrier pigeons used in the Italian Army. The Italian war balloons, unlike ours, are of the "sausage" type, and they were used in the disastrous campaign in Erythrea, when Italy's colonial aspirations were nipped in the bud.

In the matter of balloon-signalling some most successful experiments were made during the French Army manœuvres in the autumn of 1901, when, for the first time, balloons were used in signalling instructions to the regiments spread over a wide area. The



BRITISH MILITARY BALLOON READY FOR ASCENT.

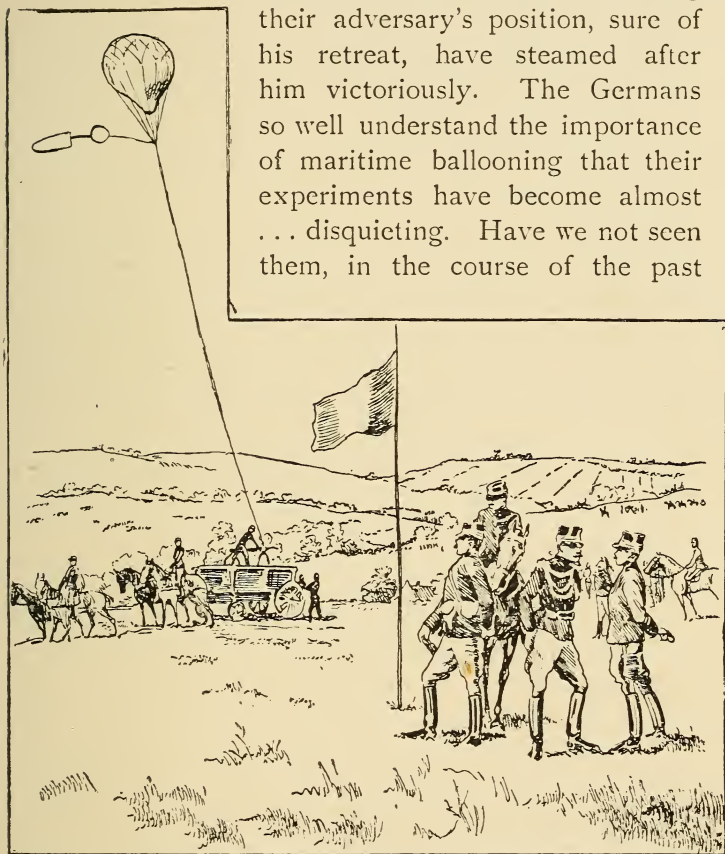
Photo by Argent Archer, Kensington.

enormous mass of men engaged, operating over miles of country, renders it difficult for the general commanding to convey orders to the whole body of the troops with anything like simultaneity. On this occasion the military balloons were provided with spheres and cones, which, used in various combinations, communicate orders of a purely general character. For instance, a single sphere means the suspension of operations, a single cone their resumption, while a sphere and a cone form the sign for the conclusion of the action, and the assembly of the superior officers for the "critique." Along these lines the military balloon can render most valuable assistance in the controlling of a widely disposed army.

It has been mentioned that Count de la Vaulx's abortive attempt to cross the Mediterranean was, *inter alia*, an experiment to test the adaptability of the balloon for certain military uses. How the mind of the continental strategists is bent at present may be gathered from these words of Lieutenant Tapissier, who accompanied the count in "La Méditerranéen":

"There will come a moment when, in the course of long hostilities, there will be no longer any unities, even the most modest, to sacrifice in order to obtain certain indications on which may depend the issue of a combat. Take an example from the Cuban War. The Americans found themselves one day in the most cruel embarrassment. They knew that Admiral Cervera's squadron was near them, that it might appear at any moment, so that they hesitated, undecided. Mountains, which they could not scale,

hid the fleet of the enemy. If they had been in possession of a balloon, instead of remaining in forced inaction, they might, knowing their adversary's position, sure of his retreat, have steamed after him victoriously. The Germans so well understand the importance of maritime ballooning that their experiments have become almost . . . disquieting. Have we not seen them, in the course of the past



BALLOON-SIGNALLING IN THE FRENCH ARMY. SIGNAL TO "CEASE FIRING."

year, over Lake Constance, giving themselves up to the most expensive kind of experiments with an

automobile balloon, which, had it turned out a success, instead of a failure, might have come pacifically but proudly to promenade the German colours in the sky above Paris?"

In England we have not altogether stood still in the matter of experimental military ballooning, though strangely enough the most valuable demonstration of how aeronautics may become the chief branch of military service has been given by one who is a follower of the Prince of Peace—the Rev. J. M. Bacon, who, in 1900, when accompanied by Admiral Fremantle, conducted some remarkable experiments in signalling from his balloon with the troops encamped on Salisbury Plain, and again, at the meeting of the British Association in Bradford, carried out some successful experiments in wireless telegraphy, whereby he exploded a mine in the gardens whence they had started, when three or four miles distant in the sky.

But, as we have said, the simple balloon is limited in its scope. If ever aerostats are to become *active* weapons of war, it will be when the secret of steering has been finally disclosed. They must be capable of answering to the helm and not merely at the mercy of the air-currents. Mr. Bacon's experiment might have been a failure if the wind had not been suitable, and in war there must be no "might have beens." As Lieutenant Tapissier has grimly hinted, what military men are after is an airship from which it will be possible to drop down deadly explosives into "thick peopled cities," or into the ranks of an army. Long ago the prophetic mind of

Tennyson shadowed forth such a terrible possibility, when he "dipt into the future" and

Heard the heavens fill with shouting, and there rain'd a
ghastly dew
From the nation's airy navies grappling in the central blue,
Far along the world-wide whisper of the south wind rushing
warm,
With the standards of the peoples plunging thro' the thunder-
storm.

It may be that this new terror will be born from the womb of the Twentieth Century, and if it be, God grant that the poet's further vision may also come true :

Till the war-drum throb'd no longer, and the battle flags
were furl'd
In the Parliament of man, the Federation of the world.

CHAPTER IX.

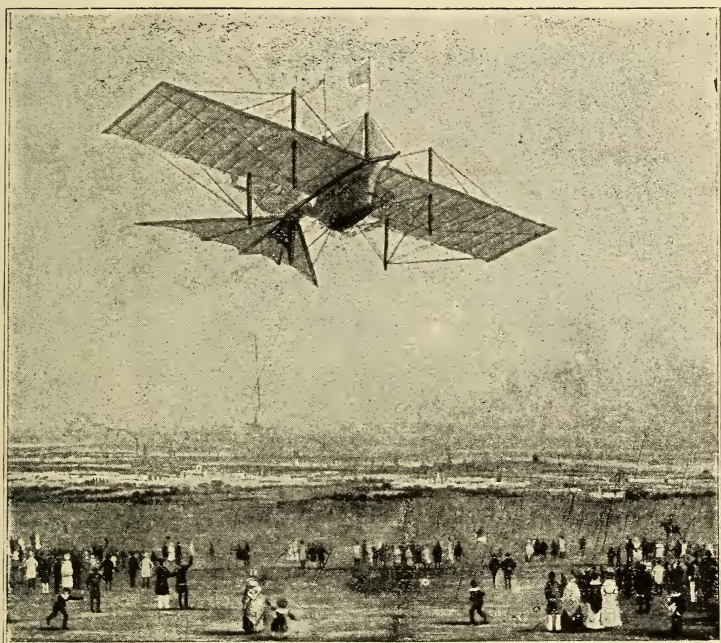
Airships of Yesterday and To-day—Sir Hiram Maxim—Dr. Barton
—T. H. Bastin—William Beedle—An Austrian Failure, etc.

TO give any adequate sketch of the airship as distinct from the balloon would call for a work considerably larger in size than the present volume, as there has been far more experimenting and far more failure in this direction than in ballooning pure and simple. We intend for the present to content ourselves with a brief survey of the most important schemes now before the world for the navigation of airships. But a word or two should be said, by way of introduction, about some of the most famous failures of bygone days.

Perhaps the earliest of all attempts, and not the most absurd, was that represented by Francis Lama's airship, made, but probably never raised into the air, in 1670. Its lifting power was to be four copper globes from which the air had been expelled. Any schoolboy to-day knows that such a thing would be impossible, and instead of having ascensional qualities, globes of this kind would be certain to collapse from pressure of the outside air.

Blanchard, who was the first to cross the channel in a balloon, claimed, in 1784, to have guided his

aerostat with sails; but this was never accepted as a fact. Monck Mason, in 1843, adapted the screw and rudder to an egg-shaped balloon and produced something slightly resembling Santos-Dumont's air-

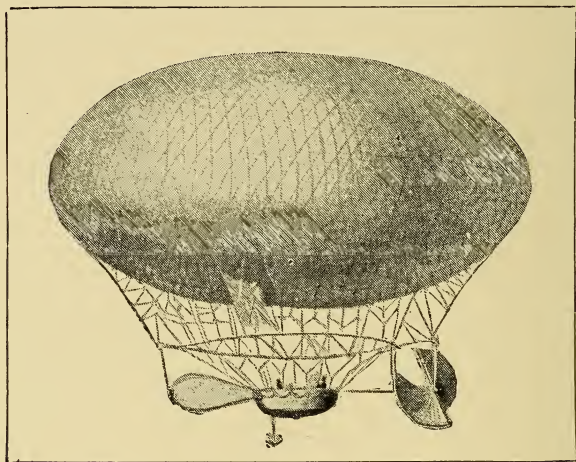


A NAVIGABLE AIRSHIP OF FIFTY-EIGHT YEARS AGO: THE FIRST
STEAM CARRIAGE OF "THE AERIAL TRANSIT COMPANY."

ship; but it was a failure. In the same year a company was actually formed under the name of "The Aerial Transit Company" to do business in carrying goods and passengers on navigable airships propelled by steam. It was not a brilliant success, and its shareholders never handled fat dividends! Its

airship was a weird contrivance in which the principle of the aero-plane, the ordinary ship, the tail of a bird or fish, and other incompatible things were all associated.

Seven years later, Bell, with an acrostat on very similar lines to Monck Mason's, made an ascent from Vauxhall Gardens, but with no greater success. The same year saw the most ludicrous proposal for navi-



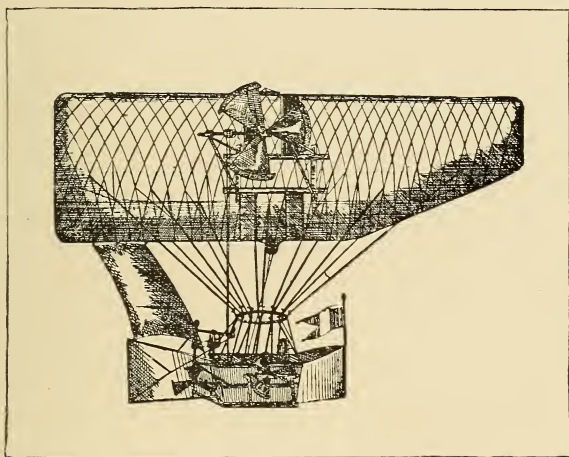
MONCK MASON'S MODEL AERIAL MACHINE, 1843.

14 ft. by 6ft. 8 in. high.

gating the air ever born in the mind of man. It was known as "Peter's Patent," and is quite beyond description, so that we can only hope to refer our readers to the picture of it (page 146), which speaks more eloquently than words. In 1865 Delamarne ascended frequently from Cremorne Gardens in an "aerial sailing-balloon," of very ingenious construction, with which he had some measure of success. But

the only instance of a balloon being steered, previous to the most recent achievements, was Commandant Renard's balloon, in which, as we have mentioned, Gambetta escaped from beleaguered Paris.

We have already dealt very fully with Santos-Dumont and his airship, so that we may pass at once to notice some of his many rivals for the kingship of the sky. We naturally turn first to Sir



M. DELAMARNE'S AERIAL SAILING-BALLOON, "L'ESPÉRANCE," AT CREMORNE, AUGUST, 1865.

Hiram Maxim's flying-machine (see frontispiece), which exists here in London to-day, and from which great things are expected. As we have heard, Sir Hiram's airship belongs to the "heavier-than-air" variety, and is thus totally opposed in principle to Santos-Dumont's. His great machine consists of a series of aero-planes, somewhat suggestive of a vessel's sails, supported above a platform on which the motive

power is situated, and between the aero-planes and the platform are two immense propellers, which grip the air with a forward movement. The principle of the machine is, of course, that when the aero-planes, which are readily adjustable, are fixed in given positions according to the winds, and the propellers are in action, the machine rises in the air in the same way that a bird raises itself. To the eye the Maxim machine looks a most workmanlike craft.

A celebrated scientist has said "the atmosphere is solid if you strike it hard enough." So power is the great essential in driving the aero-plane, and this Sir Hiram Maxim believes he can supply, as will be gathered from his own description of his machine :

"In the early experiments, conducted by myself," he writes, "I found that an aero-plane six feet long and one foot wide, made sharp at both edges, and driven through the air sidewise at a slight angle above the horizontal, would carry 133 pounds to the horse-power at a velocity of forty miles an hour. My early experiments were conducted with a great deal of care. I was provided with dynamometers—in fact, with a sufficient number of instruments to enable me to ascertain exactly the lift of the plane, the power consumed, and its velocity through the air. Professor Langley at about the same time conducted similar experiments, but with aero-planes about four inches wide, and eight or ten inches long. With these small aero-planes, made of metal, the professor succeeded in carrying at the rate of 250 pounds to the horse-power. In some later experiments, conducted by myself, I found that an aero-plane

one foot wide, made very sharp at the edges and slightly concave on the under side, and placed at only a slight angle above the horizontal, had a lifting effect eighteen times as great as the tendency to travel with the wind—that is, the lift was eighteen times greater than the drift. Similar results have also been obtained by Mr. Horatio Philips.

“With an aero-plane consisting of woven fabric drawn tightly over a frame, I found that only forty pounds could be carried with the expenditure of one horse-power. With my large machine, however, the results were even worse. I was forced to use a light framework covered with thin fabric, and in order to support this, and to give it the necessary stability, a great number of steel braces and wires had to be employed, and all these offered great resistance to being driven through the air. I finally ran up the power to 360 horse-power, and with this immense expenditure of energy I succeeded in getting a screw thrust of 2,200 pounds, and a lifting effect of 10,000 pounds. It will therefore be seen that instead of lifting eighteen times my screw thrust, as in some of my small experiments, I lifted less than five times.”

From this it will be gathered that Sir Hiram Maxim's aerial machine is still, in some particulars at least, in the experimental stage; but in the hands of a man of such inventive genius it is almost certain to be brought to success.

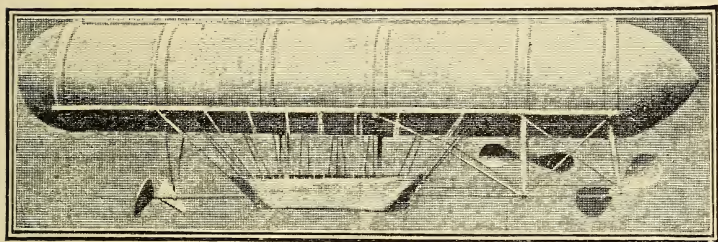
Another British machine still in the experimental stage as we write is that which Dr. Barton, of Beckenham, is constructing for the War Office. The machine is, we are told, a combination of the balloon-

screw-propeller, and aero-plane principles, and will be, when completed, 200 feet in length. It will have a lifting capacity of between four and four and a half tons, the crew consisting of three men, and the vessel will be propelled by six screw-propellers driven by two light petrol-engines, capable of developing seventy-two horse-power. It is expected that its maximum speed will be thirty miles an hour. It will be equipped to remain in the air for forty-eight hours. The metal used is principally steel, which has been selected in preference to aluminium, this having been considered more brittle and less durable. The two main features of the vessel will be its absolute stability and its adjustable aero-planes. These are the essentials of the machine, and their principles are secrets which have not been divulged ; but it is understood that the means for maintaining the centre of the vessel's gravity will consist of two tanks at each end of the vessel, which will contain a quantity of water, to displace which small pumps will be utilised. The gas vessel will be divided into compartments, and will be made of silk.

It is important to note that Dr. Barton believes that his machine will be able to fly without the assistance of the balloon, and hopes that ultimately the latter will be dispensed with. In the construction of his airship, he has calculated throughout for double the conditions imposed by the War Office, which are that the government would purchase the machine if it were able to travel thirteen miles an hour in a calm, to carry one man, and to remain in the air for two days.

There is yet another British airship to be noted, the invention of Mr. William Beedle, of Cape Town. It appears that Mr. Beedle is a resident of Cape Town, and an engineer who has been seven years in perfecting his machine. He claims to have reached the high-water mark in aerial navigation, and the fact that the well-known English firm of experts, Messrs. Spencer and Sons, is identified with him is proof of the merit of his invention.

The plan of the Beedle airship is that of a car



BEEDLE'S MACHINE.

suspended from a cylindrical balloon, holding 18,000 feet of hydrogen. The length of the balloon is 100 feet, and the diameter sixteen feet. The untearable balloon skin is attached to the inside of six aluminium hoops, which are so placed as to render the balloon collapsible and provide a ready vacuum when refilling, and also increase the foot-power by forty-two pounds. Three lengths of nickel steel tubing, each eighty feet long, are attached to the hoops, to which are suspended the car, motor, and fans.

Driving an airship is an accomplished fact, but where Mr. Beedle is thought to score over his rivals is in the steering and lifting. His steering gear is

at the front, and turns the nose of the craft, while his driving is done from the rear with a twenty-eight horse-power motor cooled with four air cylinders.

The whole machine is portable, and we are assured that it marks a distinct advance upon Santos-Dumont's, Renard's, or Deutsch's ship. Mr. Beedle hopes to travel at the rate of forty miles an hour. He himself considers that his machine is greatly superior to Santos-Dumont's, of which Mr. Beedle says :

"He uses a rudder which steers to the right and left, and does not possess the fine points of steerage which I claim to have invented."

The weight of the machine is 1,260 pounds, and the loss of gas during an ascent will be overcome by compressed gas carried in a tube. The lifting power is just sufficient to raise the vessel from the ground, when the fan comes into play. The nose of the craft cants upwards, and away it goes in any wind. The machine carries two men. It has the warmest approval of M. W. de Fonvielle, the celebrated aeronaut, and it certainly appears to be a far more workmanlike production than the great spidery machine with which Santos-Dumont carried off the Deutsch prize. At the time of writing, trials have only been made with a thirty-feet model, but there is every reason to believe that the Beedle airship possesses all the qualities its inventor claims for it. It is to compete for the second Deutsch prize in 1902.

Still one more British airship to be mentioned, and one differing totally from the Beedle or Maxim plans. Mr. T. Hugh Bastin, of Clapham, has been engaged upon the consideration of flying-machines for seven-

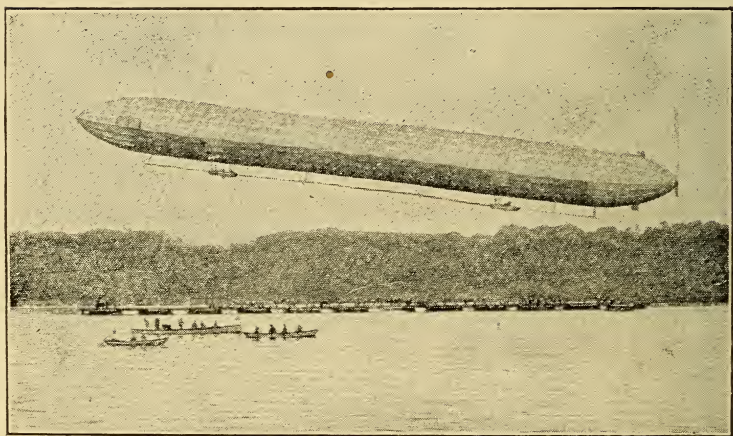
teen years, and has evolved a design which will reproduce mechanically the action of a bird's wings in supporting and moving a weight through the air.

Mr. Bastin's drawings have been examined by an expert, who describes the invention as "a mathematical triumph in which the employment of a differentiating crank secures the eccentric motion that is necessary to attain the reproduction of the beat of a bird's wings." The body of the ship is designed to be cylindrical in shape, and the construction of the wings is made upon the plan of those of a fly, inasmuch that it is ribbed and balanced to a thousandth part. One man controls the machine with a battery of five levers, and the rate of speed promised is abnormal.

It will be gathered from this that the machine will have wings constructed on nature's plan, and will be heavier than the air, with power of controlling or counteracting its weight and of producing the energy necessary for progression and evolution. The machine will carry a considerable burden in addition to its structural weight, and the whole will be so distributed below the wings that the machine cannot be overturned.

No account of airships of to-day can neglect to notice Count Zeppelin's amazing aerostat. This is on such a gigantic scale that the mind is positively appalled with a mental picture of it. Conceive, if you can, a large man-o'-war floating over Trafalgar Square, and you have some idea of this extraordinary ship of the air. It consists of a cigar-shaped vessel of aluminium, 420 feet long, thirty-eight feet in diameter, within which are enclosed *seventeen* separate balloons,

each independent of the other, the total capacity being 14,780 cubic yards. Suspended from this monster aluminium vessel are two small cars about ten feet long of the same metal, both situated some 110 feet from each end of the giant cylinder, and connected by means of a narrow gallery which affords a walking distance of 326 feet—longer than the decks of many ocean-going steamers. In the



THE ZEPPELIN AIRSHIP OVER LAKE CONSTANCE, JULY 2ND, 1900.

bottoms of the cars are tanks containing water which is used for ballast, and they are connected with a speaking-tube, so that the occupants of the one can follow instructions from the other. There are two motors—one in each car—capable of developing sixteen horse-power each. The air-propellers are very small compared with the bulk of the entire machine, and rudders are fixed at both ends, but the steering gear at the nose of the craft is the more

important. This enormous structure took years to build, and was tested in the summer of 1900 with satisfactory results, being easily *dirigible* and floating safely on the surface of the water when desired ; but its utility as a contribution to the solution of aerial navigation is very small indeed. It is as though the s.s. *Britannic* could only carry a dozen people on board, all told ! The energy expended is out of all proportion to the result obtained.

The sensations caused by Santos-Dumont's failures and successes naturally produced a whole series of experiments in France, and in the autumn of 1901 almost every day brought forth news of another flying-machine that was "about to be tried," or would be put to the test "at an early date." One of the most forward of these rivals was M. Roze, whose airship was an accomplished fact before Santos-Dumont won the prize. The Roze airship differs from all its competitors in having two cigar-shaped balloons, with sharp metallic points placed on each side of the carriage. It depends for its buoyancy entirely on the lifting power of these balloons, and is furnished with screw propeller and rudder.

In one day the Paris correspondent of the *Daily News* reported six fresh "rivals to Santos-Dumont." These were: Baron Bradsky, (an Austrian) whose airship was said to be very similar to that of the Brazilian aeronaut, and would be supported by means of a balloon—the now familiar cigar-shaped one—of a cubic capacity of 22,000 feet, and twenty-eight yards in length. The motor was to be one of twenty horse-

power, instead of Santos-Dumont's (then) sixteen horse-power. Baron Bradsky was confident of success.

Visitors to the 1900 Exhibition (the correspondent went on) may have noticed hanging up in one of the Champs-de-Mars galleries M. Ader's "Aviateur," or airship, looking like a gigantic bird. M. Ader is a Toulouse engineer and he hopes to be able to fly shortly. Colonel Renard and his brother, the major, are working at the military park of Meudon, and it is probable they will bring out something. The Marquis de Dion, who builds motor-cars, intends to build an airship, but no details are known. M. Deutsch, the founder of the £4,000 prize, is competing for his own prize, or at least M. Tatin, a very able engineer and aeronaut who is working in partnership with M. Deutsch, is. Lastly, M. de Simoni is designing, at Suresnes, an airship which will combine the principle of balloon and aero-plane.

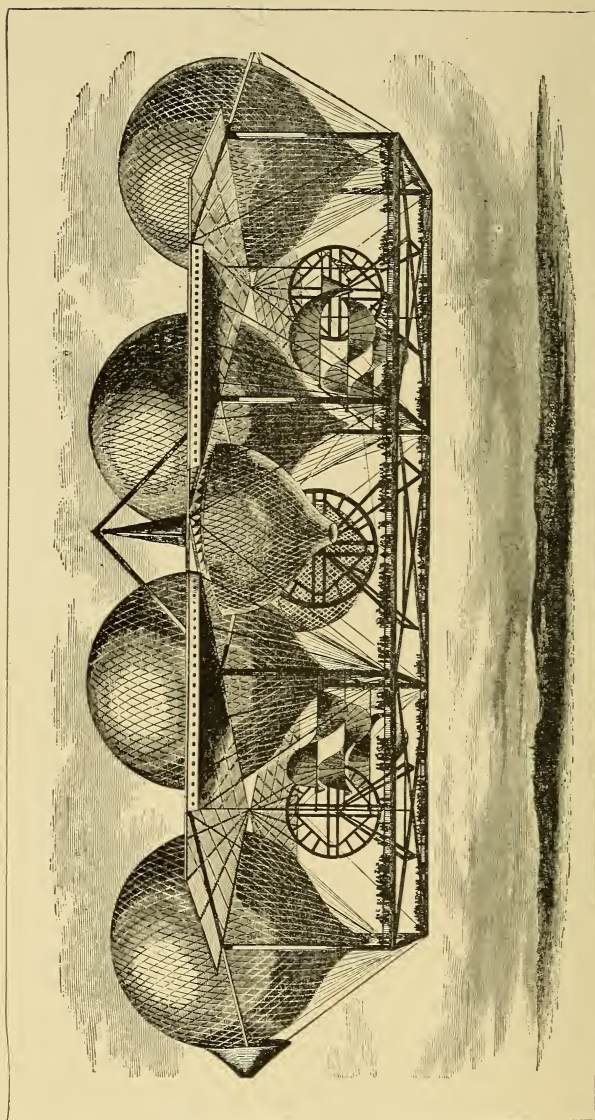
Assuredly, if we are not all flying about the skies a few years hence, it will not be for lack of experiments.

A rival from his native land also came over from Brazil to compete with Santos-Dumont for the aerial supremacy in that memorable autumn. This was Señor Augusto Severo, a member of the Brazilian Chamber of Deputies. At the time of writing we have no *facts* to go on, but the *Pall Mall* correspondent's account of a visit to Señor Severo's balloon shed at Vaugirard is interesting :

"One sees only workmen screwing together a strong wooden framework, which is the base of the machine, and which will carry two motors, a large one of forty horse-power behind, and a sixteen horse-power

one in front. At present there is no sign of the mechanical parts in aluminium—the motors and the seven great screws which are to act as propellers and as the steering apparatus—because they remain at the different engineering works, some in the immediate neighbourhood, some a considerable distance away. . . . Close to the dynamo are a number of great tanks, in which will be stored the hydrogen with which to inflate the balloon. It is somewhat singular that, bordering on this piece of ground is another wooden erection, also consecrated to the aeronautic science by an enthusiastic amateur. One begins to suspect that every street in Paris nurses some aspirant to aerial honours. It is amusing to hear M. Severo, in his voluble French, strongly tinged with an accent, describe the 'Santos-Dumont' as 'a great toy,' though he pays a handsome tribute to the pluck of his compatriot. M. Severo told me his experiment will cost him £3,000. If he is successful in directing his balloon round Paris, the problem of the air will be solved. 'I shall then sail my ship to London, and next year I shall build one that will take me to Brazil.' There is nothing but cheery optimism about M. Severo."

It was also announced in September, 1901, that the plan of another steerable balloon had been put forward by M. Jean Vannylen, a Belgian draftsman, which during a tempest would conquer wind currents in long journeys of hundreds of miles. The balloon was to be ready for the Deutsch prize of 1902. It was to cost 50,000 francs, of which 20,000 francs had been subscribed at the time of the announcement.



PETER'S PATENT, 1850.

Sad was the fate of a machine invented by an Austrian rival to the young Brazilian. Herr Wilhelm Kress is an old man and poor, who constructed a flying-machine of the "heavier than air" description. According to a Vienna correspondent, who examined his machine, it looked like a huge bird with three enormous wings. But close inspection showed that there were also five screws—two for driving, three for steering. These screws were worked by a powerful petroleum motor. The body of the machine was shaped like a boat, but had two keels parallel to one another.

Kress's theory of aerial flight is in his own words thus expounded: "When a boy flies a kite he runs with it against the wind as fast as possible till it rises. I propose to drive my airship against the wind faster and faster till it rises. I call it for this reason the 'Kite-flyer.' Once in the air the three wings will aid the screw in sustaining the weight of the apparatus, which is considerable, the engine alone being 700 pounds."

His confidence seemed justified, and experts reported so favourably on his apparatus that the Emperor Francis Joseph contributed £2,000 towards the expense of its construction, and many wealthy Austrians had also put money into the venture.

But, alas! for the sequel. On Thursday morning, October 4th, 1901, he took his airship, which floated on water, across Lake Tullnerbach, near Pressbaum, and after adjusting his screws and levers he put on full speed for the ascent. The airship began to skim the surface of the water, and suddenly rose like a bird. Success seemed assured, but it was not

for long. Something went wrong—what it was is not exactly known—the airship turned turtle and fell into the water, in which it sank like a stone. Kress, who remained calm, was rescued by a boat. The ship was understood to be lost beyond recovery.

One of the most curious reports circulated during these eventful days was to the effect that a factory had been erected in the town of Pittsburg, Texas, for the purpose of building airships on a plan invented by the Rev. B. Canon, a local clergyman, who asserted that he obtained his idea of the new principle from the book of Ezekiel in the Bible, and that he had reached an absolutely successful solution of the problem of aerial navigation. He was said to have completed his first airship, which had been tried at Pittsburg, with great success. This is all that we have heard of the “Texan,” and the only passage suggesting aerial navigation that we can find in the book of Ezekiel is the following, which describes one of the prophet’s visions by the River of Chebar :

“Out of the midst thereof (the opened heavens) came the likeness of four living creatures. And this was their appearance ; they had the likeness of a man. And every one had four faces, and every one had four wings. And their feet were straight feet ; and the sole of their feet was like the sole of a calf’s foot : and they sparkled like the colour of burnished brass. And they had the hands of a man under their wings on their four sides ; and they four had their faces and their wings. Their wings were joined one to another ; they turned not when they went ; they went every one straight forward. . . .

Thus were their faces : and their wings were stretched upward ; two wings of every one were joined one to another, and two covered their bodies. And they went every one straight forward : whither the spirit was to go, they went ; and they turned not when they went." This does not read very like a practical guide to the art of flying. How is the Rev. B. Canon going to get over the difficulty of the cloven feet ? And the four faces ?

Finally, we cannot pass from this subject without reference to the kite-flying experiments of Mr. S. F. Cody on Wanstead flats, early in November, 1901. His apparatus is extremely simple, and consists of four kites, the largest of all being a huge structure resembling the framework of an oblong box. The length of the structure is twenty-seven feet, the width thirteen feet, and the height five and a half feet, while there is a spread of 675 square feet of the best "Irish linen" canvas. To this is attached, by means of a cable at a distance of 100 feet, another smaller kite, similarly constructed, then another again, and finally, a "pilot kite." Mr. Cody is suspended in a basket-chair from the largest kite, which is connected by 860 yards of cable wire to a windlass. The windlass with its patent brake—another invention of Mr. Cody's—is mounted on a moderate gun-carriage, which is made secure and stationary by means of a large spike fixed in the soil. The kite, of course, would be limited in use to captive ascents.

Out of all these inventions and experiments it is not too much to hope that the perfected flying-machine will emerge at no far distant date.

CHAPTER X.

Is Aerial Navigation Practicable?—The Limits of Ballooning—Santos-Dumont's and Sir Hiram Maxim's opinions—A Humane Use for the Balloon.

Is aerial navigation practicable? "A foolish question," you say. And ask, "What about Renard, Zeppelin, Santos-Dumont, and all the rest?" Simply this: no one has yet been able to steer an airship in any but "favourable weather," or moderately adverse winds; and we know that vessels that are only seaworthy in calm weather are of little account for general purposes.

There are men whose aeronautical experience entitles their opinions to our fullest confidence, who stoutly maintain that a steerable balloon is utterly impossible. They hold that Santos-Dumont has only proved that it is possible to make a short trip in a steerable balloon under favourable weather conditions, or, at most, when the atmosphere is not sufficiently disturbed to be equal to "rough weather," as reckoned by sailors. This had been proved before Santos-Dumont took to ballooning.

But it is a curious fact that a great many inventions and discoveries have been made by men whose training has lain quite outside the field into which they

have brought new and undreamt-of knowledge. Perhaps, after all, the veteran balloonist is the last man in the world to give a weighty opinion on this question; the amateur, the professional "outsider," may be the very man to solve the problem, as he is bound by no traditions, affected by no prejudices of experience.

Having taken our readers over a fairly comprehensive survey of the rise and progress of ballooning, it may be well in this final chapter to examine frankly the pros and cons of the question of steering, even at the risk of a little repetition. And we might here remark that repetition in writing of ballooning is almost unavoidable, for, despite the wonderful variety of aeronautical experiences, no art or science has altered so little in the course of a hundred years, and the essentials of the subject admit of very brief discussion.

The flight of a bird has often been taken in illustration of the ideal to which men who would soar in the air must seek to attain. But there is not much to be learnt from the bird's flight, beyond one important fact. There is no possible comparison between the anatomy of a bird and a man, and though it is possible to explain precisely how a bird flies, it is impossible to imitate it. To start with, a winged man would require pinions of enormous spread, and machinery of the most complicated kind to keep them in action, in order to secure the ratio say between an eagle and its wings. It is proved that in the action of lifting its wings a bird meets with little or no resistance. This is known by the muscles used for that purpose being very weak, while those

used for the downward sweep of the wings are extremely powerful. It is also known that as the bird brings its wings downward they are inclined backward, and the resistance which they thus meet with from the air acts as leverage to raise the bird. Here, then, is a valuable principle for the aerial experimentalist. It is exactly the same principle on which a boy raises his kite. The kite is inclined at an angle *against* the wind and is thus forced upwards. Let us remember this, for we shall have occasion to consider this principle presently.

But we may dismiss from our thoughts all ideas of "imitating the birds in every respect"—they are cranks who pursue that kind of experiment.

Thus are we limited to three kinds of aerial machines: the simple balloon; the balloon combined with machinery for steering and propelling it; and the airship which dispenses completely with the balloon and relies solely on machinery for raising, lowering, flying, and directing its course.

It is almost useless to discuss whether an ordinary balloon can be steered. The answer is an emphatic, No. Very early in the history of ballooning it was attempted, and for many years now no aeronaut has been so foolish as to try what has long been proved impossible. Remember the nature of a balloon. It is simply a silk or linen bag, filled with hydrogen or carburetted gas. Hydrogen weighs about one-fourteenth the weight of ordinary air,—the weight of which is about 530 grains per cubic foot, or nearly two pounds to a cubic yard,—while ordinary carburetted gas is about one-half the weight of the

air. These gases, enclosed in an envelope, can rise up through the air until they reach a region where they are but slightly lighter than the air itself. Weighted with a car and all the usual fittings of a balloon, including the aeronauts, they can never reach such a region, but float in atmosphere considerably heavier than the gas they contain.

Their power, however, is limited entirely to *ascent*. Descent is accomplished by liberating some of the gas until the weight of the atmosphere outside presses the balloon to earth. It is thus seen that the balloon is lighter than the element in which it floats, and is carried resistlessly with that element. Try to make it go contrary, crosswise, to the motion of that element and you are trying to do something on a par with attempting to force a quill pen through a wooden door. No ; an ordinary balloon has never been, and never can be steered to right or left.

Some success, however, has been attained with aerostats of the Santos-Dumont type. That has been very fully described already, and we need not recapitulate, beyond stating that such machines have always been provided with balloons which, being pointed at the ends, give as little resistance as possible to their passage through the air. But obviously the same difficulty of forcing the balloon against the air, which obtains in the case of an ordinary balloon when one attempts to steer it, must arise in the case of a Santos-Dumont or Zeppelin airship, modified to this extent, that the latter aerostats have also a mechanical means of propulsion and are not dependent entirely on the wind for

motion. However, let us hear what Senor Santos-Dumont has to say on this point. An interviewer asked him recently :

“Do you find it difficult to maintain the rigidity of the balloon when driving against the wind?”

“No,” he replied, “that is counterbalanced by the interior pressure. Of course I have no framework for the balloon, but the atmospheric pressure brought to bear upon the interior answers. On the day that I rounded the Eiffel Tower the rate of the wind was certified by the meteorologic authorities as being eighteen miles an hour. In starting out I had that with me, and did the journey of nearly four miles in eight minutes. Coming back I had to fight against the wind.”

“And the speed of your new ship?” [No. VII.]

“That should be about forty miles an hour.”

“Fuel must be an important consideration.”

“Fuel is the only form of ballast I carry. My motors will consume about sixty pounds of petroleum an hour. I shall be able to carry four hundred pounds of petroleum.”

By the way, it is only fair to the memory of Giffard, the famous French aeronaut, to state that fifty years before Santos-Dumont had achieved some success on the same lines, he built an elongated balloon which was pointed at both ends. Filled with illuminating gas, it had a sail which was to be used as a rudder. The balloon supported a small steam engine which operated a propeller. On September 24th, 1852, Giffard ascended 5,000 feet above Paris and steered his balloon against the wind,

returning safely to his landing-place. The Giffard balloon of 1852 and the Santos-Dumont model of 1901, have, as a matter of fact, a very strong resemblance.

Notwithstanding Santos - Dumont's experience, Count Zeppelin—who, before the Brazilian rose to fame, had already ascended over Lake Constance, made a short journey in the air, and returned to his starting-place—has his balloon strengthened with a metal frame to prevent the air from pressing it out of shape, and it cannot be doubted that Santos-Dumont's balloon, forced against a very strong head wind, would run serious risk of being squeezed out of shape, with the inevitable result of disaster. Indeed, his famous failure when he fell on the housetops of Paris was generally attributed to this, though the adventurous young aeronaut would appear to have persuaded himself that such was not the case.

The prime objection to acrostats of this type is the fact that they must be of enormous size to carry even one man. Their lifting power in proportion to their size is ridiculously small. The "Santos-Dumont VII." with its inventor in the car is like Sandow sweating and straining under the weight of a butterfly.

But they can be steered. That is the great thing. There we have an accomplished fact. They can be steered in fair weather, not in foul. As surely as an ordinary balloon not relying on machinery for motion can never be directed, so surely can a Zeppelin or Santos-Dumont airship never be guided through the skies with the wind blowing "more nor 'alf a gale." To achieve that the balloon part must be done away with. Señor Santos-Dumont says:

"I expect that a way will be found of dispensing with the balloon and of relying upon the motors altogether before very long, but until we get that we must make the best use of what we have."

Let us now hear what the most famous experimenter on the lines of machinery apart from balloons, or "heavier than air" machines, has to say on the subject.

"A kite held up against the wind," writes Sir Hiram Maxim, "has very great lifting power with a wind of forty miles an hour, so an aéro-plane having a velocity through the air of forty miles an hour has very great lifting effect. With a balloon high speed is impossible. With an aéro-plane speed is a necessity, otherwise insufficient lifting effect will be produced. I am therefore strongly of the opinion that we must look to machines heavier than the air, which, in reality, fly after the manner of birds. Nature has innumerable flying-machines, which are all heavier than the air, but Nature has no balloons. Therefore, if we wish to succeed, we shall have to follow in the footsteps of Nature, as we have already done in many other branches of science."

It will thus be gathered that Sir Hiram Maxim believes that the principle of the downward beat of the bird's wings is that on which the problem of rising into the air by machinery will be solved.

Writing thirty years ago, Camille Flammarion said : "A third method of aerial navigation has been brought forward in recent times, which is based upon mechanical considerations. It has been sought to

navigate the atmosphere by means of machines essentially distinct in principle from balloons, heavier than the volume of air which they displace, and set in motion by powerful engines. This is doubtless the direction in which we must look for the future solution of the problem under consideration, unless, indeed, our knowledge of the currents of the atmosphere increases to such an extent as to render aerostatic navigation possible by their means."

There can be no doubt that the future of aerial navigation is with some such machine as that on which Sir Hiram Maxim is experimenting. It may be many years before perfection is attained, but attained it will be some day, and we may live to see

. . . the heavens fill with commerce, argosies of magic sails,
Pilots of the purple twilight, dropping down with costly bales.

Meanwhile, the old-fashioned balloon has by no means been displaced. For there is the other line of research to be prosecuted: the study of air currents. If the heavens could be charted as the ocean has been—and there is no reason to consider that impossible—the ordinary balloon would pass at once into a new sphere of usefulness. To know where a certain wind was blowing would only be the prelude to rising into that wind and floating with it as far as one wished to be carried. To know where other winds were blowing would be to know which part of the skies to avoid drifting to.

Already we possess a vast amount of knowledge on this subject. We have heard that M. Goddard contemplates a balloon voyage across the Atlantic.

Speaking about this a French aeronaut of wide experience said to a magazine correspondent recently:

“The two Atlantics, north and south, like all the rest of the earth, are divided into parallel meteorological zones, which oscillate a little from south to north and inversely, following the movement of the sun’s declination. The centre, or torrid zone, near the Equator, is that of calms and equatorial tempests. No balloonist would attempt its dangerous stretches—as dangerous in calm as in storm. The next, in the North Atlantic, is the tropical zone or that of the trade winds. It is very well-known, but its general air-current, though so regular, would have the danger for the balloonist of conducting him *too regularly* into the bad preceding zone. Next comes our own zone—the temperate. It is this that M. Goddard will attempt to exploit, seeking to start off on a north branch of the trajectory of a depression. But, if you consult the pilots’ charts, you will observe that many of the northern branches of these depressions trend up to the glacial regions, between Greenland and the Scandinavian Peninsula. I think it is useless to insist on the dangers of the glacial zone itself. It is only too celebrated in ballooning annals since the going off of the unfortunate Andree. From the meteorological point of view, therefore, M. Goddard cannot derive much encouragement. Well, from another point of view, it is still worse. The solitudes of the ocean, always immense, have only increased since the disappearance of sailing vessels which were obliged to follow varied routes, complicated and lengthened by the probable winds which they were

then obliged to study. To-day the great Atlantic liners follow narrow ocean 'lanes.' Outside them there is blank solitude. A floating balloon 'basket' might float without being seen for months should it happen to fall outside these 'lanes.' It is true that M. Goddard has the intention of carrying a little petroleum launch, but could he even manage to float it in case he came down rapidly in an accident?"

The method of sending up pilot balloons to indicate the direction of the wind is the nearest approach at present to guiding the ordinary aerostat, but there still remain many uses for the non-steerable balloon. In September, 1901, for instance, some interesting experiments were conducted at Ostend to test the utility of a balloon for carrying life-lines from a wrecked ship to the shore. The experiments were conducted by Captain Regnaud, of the Ministry of Marine, and M. Vincent, an engineer, with a balloon prepared by Colonel Renard, which carried a cable several kilometres in length. At first the attempt was a failure, as the balloon merely took the direction of the wind, which was blowing off-shore, and thus prevented the cables from reaching the land. MM. Regnaud and Vincent then attached the balloon to a Hervé guide apparatus, such as was used in the Count de la Vaulx's unsuccessful attempt to cross the Mediterranean. This answered admirably.

On the whole, the experiments were held to prove that a balloon carrying shore cables would enormously mitigate the horrors of shipwreck on large liners and emigrant ships. It is indeed cheering to know that

such a noble use has been found for an invention that had for upwards of a hundred years been regarded as little more than a toy or a means of providing adventure. The Hervé guide apparatus, which has been described in an earlier chapter, is, of course, only of use when sailing over the water. Nothing is ever likely to displace Green's guide-rope for ballooning above the land.

To sum up: the ordinary balloon will only be partially directable when the air-currents have been charted; the *ballon dirigible* of the Zeppelin and Santos-Dumont type will never be controllable in strong head-winds; to the "heavier than air" machine, using aero-planes on the Maxim principle, or some other invention, we must look for the final solution of the problem of aerial navigation.

THE END.

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